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Revenue Reports

OF THE

GANGES CANAL,

FOR THE YEAR 1855-56,

BY

LIEUT.-COLONEL R. BAIRD SMITH,

SUPERINTENDENT GENERAL OF CANALS, N. W. P.

IRRIGATION IN EGYPT,

BY

CAPTAIN J. G. FIFE, BOMBAY ENGINEERS.

CALCUTTA:
JOHN GRAY, "CALCUTTA GAZETTE" OFFICE.

1856.

NOTE.

In the original Reports there were three Maps showing the gradual progress of the Rajbuhas. These have been combined into two in this reprint of the papers, one showing the condition of things at the end of the Khureef, the other their state at the end of the Rubbee, 1855-56.

FIRST REVENUE REPORT

OF THE

GANGES CANAL,

BEING FOR THE

FUSSIL KHUREEF OF 1855-56.

BY LIEUT.-COLONEL R. BAIRD SMITH,

Director.

Camp Jheend, 7th December, 1855.

1. In submitting my first Report on the Revenue yielded by the Ganges Canal during the Fussil Khureef* of 1855-56, it will be expedient to connect the formal opening of the Canal on the 8th of April 1854, with the commencement of Irrigation on the 1st May, 1855, by a summary statement of the work done during the intermediate period.

2. When water was admitted into the channel in April 1854, the general condition of the works was as follows: Above the Northern terminus of the Solani Aqueduct, the channel was competent to receive and retain safely whatever supply might be admitted. Below the Southern terminus of the Aqueduct the same state of things prevailed and extended along the whole of the Main line to Nanoon, a distance of 180 miles; from the Head to Ghiror, a distance of 57½ miles, on the Etawah line; and to the 81st mile, on the Cawnpore line. It might have been safe to admit a small supply into the Cawnpore terminal line as far south as the Aima Escape at the 122nd mile, but the banks and excavation, between the 81st and 103rd miles, were incompetent to retain more than a merely nominal volume.

3. Between the Northern and Southern termini of the Solani Aqueduct however lay the works that made the maintenance of a

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* Autumn crop.—*Ed.*

continuous supply in the Canal impracticable. The Masonry Aqueduct and the left embankment of the Earthen Aqueduct were perfectly safe, but on the other hand the right embankment of the latter was throughout in a state so incomplete as to make it dangerous to keep the water in the channel. My predecessor* accordingly directed the Canal to be closed again on the 12th of April, and measures were immediately taken to push on the earth-work of the right embankment.

4. The earth required for this purpose was procurable from two sources. 1st—From the external excavations parallel to the embankment, and 2nd—From the Peerankuleear excavations at a distance of from 3 to 5 miles, and connected with the northern extremity of the embankment at Mahewar by a railway. The supply from the former was limited, as, being in the valley of the Solani, deep excavations were inexpedient, and it was therefore mainly on the latter that dependence had to be placed.

5. When the Canal was formally opened the railway south of Mahewar had just been commenced. Our first object was to have it completed along the whole line of embankment. Up to the setting in of the rains in the middle of June satisfactory progress had been made, but the great floods of 1854, by submerging the valley of the Solani, deprived us altogether of our supply of earth from it, while the heavy rains caused such frequent damage to the fresh platforms as seriously to hamper the work. It went on however, and by the end of August the rail had been carried to within about 3,000 feet of the Masonry Aqueduct.

6. At this time it appeared to myself and the Executive Officer that we might safely admit sufficient water into the Canal to form a still-water reservoir on the Aqueduct of sufficient depth to allow of boats being used to reinforce the railway operations in bringing earth. Arrangements were accordingly made for this purpose; the maximum depth was limited to 4½ feet at the retaining bund of the reservoir, and diminished gradually to the northward, so that the actual depth ranged from about 3 to 4½ feet. All the boats belonging to the Canal were employed, and found of great assistance.

7. The work advanced satisfactorily until the 9th of September, when alarming signs of failure in the masonry revetments of the right embankment showed themselves. At a point about 1,000 feet

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* Sir P. T. Cautley, K. C. B.—*Ed.*

above the Masonry Aqueduct, the rear wall of the revetment was observed to bend into the form of a bow on a length of about 300 feet. The action was instantly noticed, and within two hours the Canal was laid quite dry in front of it, and all real danger was at an end. The maximum deflection of the rear wall was 2·62 feet, and as a necessary consequence thereof the arch carrying the steps slipped and fell between the rear and front walls. So soon as the water was passed off, the front wall, forming a chord of which the rear wall was the arc, was thrust forward by the same interior pressure which had produced the original deflection in the latter.

8. This destructive pressure originated in the core of the revetment being of loose, unconsolidated earth, hastily filled in, and not rammed or tamped so as to form a water-tight puddling. The front wall proved readily pervious to the Canal water and the whole core was transformed into a fluid or semifluid mass, exerting of course great pressure on its retaining sides. The Canal bed had sunk much in front of the spot where the accident occurred, and so soon as the water was drawn off, and support thus taken from the front wall, it yielded to the pressure against it, and similarly the rear wall, by reason of the incomplete state of its supporting embankment, proved also incompetent to resist the force of the pressure from within.

9. Indications of precisely the same action but on a much smaller scale were found at a second point about 3,000 feet above the Masonry Aqueduct.

10. The facts brought broadly into view by these results were two; *first*, that while extensive settlements of the Earthen Aqueduct bed were the consequences of the admission of any considerable volume of water the front walls of the masonry revetments were endangered; and *second*, that till the right embankment was completed to its proper height according to Sir P. Cautley's original design, and had a width of not less than 12 feet at top, the rear revetment wall on that bank could not be considered perfectly secure against accident.

11. On the closing of the Canal in April I had determined that it should be permanently re-opened in the following November. The accidents above referred to having occurred in the middle of September, six weeks only were left to raise the Aqueduct bed to true Canal level, and to complete the right embankment to such extent as would effectually protect the rear wall. We had lost the aid of

the boats, and it was clear that the right railway could not possibly suffice for our wants. It was therefore determined to throw a temporary trestle-bridge across the Canal opposite the weakest portion of the right embankment, to lay down rails upon it, and thus to employ our whole available means of transport in completing the right embankment. Large parties were at the same time at work on the Canal bed, and the whole of the operations advanced so rapidly and satisfactorily that I felt myself justified in re-opening the canal on the 6th of November 1854, from which date it has been flowing uninterruptedly.

12. Simultaneously with the above operations on the Solani Aqueduct, it had been necessary to prepare for passing the floods of the Khadir* Rivers, for the first time, over the works provided for them. Between April and the middle of June all the requisite protective measures had been completed. The rainy season of 1854 proved to be one of extreme severity, and the floods fell short in depth by only a few inches of the greatest that have occurred in our experience, while in number and duration they exceeded all on record. The effects of these floods have already been reported to Government in minute detail, and in a general summary like this I need say no more than that this trial season terminated without a single serious accident, and confirmed by tests, which I would gladly have had of less severity, the perfect competency of the great drainage works as designed by my predecessor to fulfil the duty required from them. Some of the inlets were superficially damaged and the works on the Rutmoo River had given cause for much anxiety during the season, but reviewing the action of the whole series of drainage works between Hurdwar and Roorkee the results were undoubtedly very satisfactory and encouraging.

13. In re-admitting the water in November 1854, with the view to a general trial of the whole line of works on the Canal, I considered it absolutely necessary to proceed with extreme caution. My instructions were to limit the supply in the first instance to a depth not exceeding 2 feet on the Solani Aqueduct; to have soundings of the bed constantly carried on, with the object of detecting any serious settlements; to have patrols on the revetments, and large working parties in reserve, both by night and day in case of any breach occurring, and to maintain a telegraphic communication with the Dhunouri Regulator,

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* *Khadir*—A flat alluvial valley; in this case that of the Ganges.—*Ed.*

so that the water might be turned off at the dam there, and the Canal laid dry, at the briefest possible notice. The small supply above noted was to be continued until the aqueduct bed seemed to be well consolidated, and it was then to be slowly and steadily increased by a few inches at a time, until it was brought up to 4 feet, which was fixed as the maximum limit.

14. Acting on these instructions, the Superintendent of the Northern Division found himself unable to admit more than 2 feet of water until the 8th of December. After this date the supply was increased, but in January 1855 it was reported to me by Lieutenant Fraser and Mr. F. Read that, under the supply passing into the Canal at that time, the whole of the falls in their respective divisions south of Roorkee were losing their brick-on-edge flooring, and that they considered any further increase would be [illegible] until the floorings were repaired. The maximum supply therefore never exceeded 3 feet on the aqueduct, and the water first reached Cawnpore on the 2nd February 1855.

15. The maintenance of a continuous supply in the Canal led also to so considerable an extent of leakage in the masonry aqueduct as to make it very desirable to check it. In the excavations at Peerankuleear a peculiarly stiff compact and unctuous clay had been met with, and it was determined to try the effect of covering a portion of the aqueduct flooring with this material. Four arches of the right chamber were selected for experiment in the first instance, and the clay was laid on with particular care. The results were most satisfactory and on those arches leakage practically ceased. The process was then extended to the remainder of the chamber, and with equally good effect. The left chamber will be similarly treated, and I trust that no necessity will arise for our importing any expensive European material for the protection of this work. Leakage, however, still continues to some extent, though it is a noticeable fact that it becomes less and less after each closure of the Canal.

16. In consequence of the condition of the aqueduct above referred to, of the damage done to the falls, and of severe local action on the bed of various points on the Canal, whereby some of the bridges were threatened, it became necessary to make provision for repairs, and as these required a temporary closure of the canal, the Dhunouri Regulator was shut on the 1st March 1855. The closure however was limited to one month, and all work required having been satisfactorily completed within

that time, the Canal was re-opened on the 1st of April, and the supply was rapidly raised to its previous maximum of 3 feet on the aqueduct. The water then passed with great rapidity down the Canal, and was only about a week in reaching Cawnpore, proving that the long tract of pure sand, extending over about 70 miles of the Northern portion of the Canal, which had been regarded with anxiety, was in fact no serious obstacle to the free flow of the stream. The Canal has not been closed again except for a day or two during the rains, from the 1st of April up to the present time, and the supply has been maintained at from 4 to 5 feet on the aqueduct without difficulty or danger to any of the Khadir works.

17. In obtaining the supply during the trial season, it early became apparent that the means used in dealing with the River Jumna were altogether inadequate to give us command over the Ganges. The volume and force of the latter in the main channel at Hurdwar were so great, that intolerable delay was caused in throwing into the Canal even the limited supply we required. New plans were accordingly adopted by Lieutenant Fraser and Mr. William Kay, and as these have been detailed elsewhere, I need only state here that so completely have they established our control over the river, that with eight or ten days of actual work, we are now competent to throw the whole volume of the River Ganges into the Canal, should such a course ever be necessary. I consider this one of the most satisfactory results of the trial season, as relieving all anxiety concerning the provision of water.

18. I trust that the foregoing sketch will suffice to show that no permanent supply could safely have been maintained in the Ganges Canal prior to the 6th of November 1854, and that a short season of trial for perfectly untried works was a fair professional necessity subsequent to the admission of that supply. It was under such convictions that my predecessor and myself had fixed the 1st May 1855 as the date from which water might be offered to the Zemindars, with reasonable security against disappointment to them from frequent interruption of the supply, the moral effect of which would have been most discouraging to irrigators.

19. The same period was also the earliest at which the Rajbuhas required for the distribution of water could be sufficiently completed to warrant the admission of an irrigating supply into them, and I shall now detail in general terms as above, the progress that had been made in this department.

20. Preliminary surveys had been made for portions of the main Rajbuha lines in the 2nd and 3rd Divisions, prior to the formal opening of the Canal in April 1854, but the work required on the Canal itself in preparation for that event was sufficient to occupy all the time and labor at the disposal of the Divisional Officers. Immediately afterwards however the attention of Officers was directed to the necessity of pressing forward the D[illegible]bution Channels with all despatch, and by the 1st of June 1854 the surveyed portions of the lines were all commenced upon. After the rains field work was resumed, the surveys of the whole main lines and of such feeders as were required were completed, and working parties employed upon them.

21. The accompanying sketch map represents the actual condition of the Rajbuha system during the Khureef of 1855-56. In this the lines into which water was admitted during the Khureef under review are represented by continuous blue lines; those which were so far advanced as to be ready for the Rubbee succeeding are shown in continuous red lines, while the lines marked out and surveyed for execution during the current working season are shown by dotted red lines. The general results are as follows :—

		Miles.
Completed for Khureef of 1855-56 and having had water in them, ...		225
Completed for Rubbee* of 1855-56, ...		167½
Marked out, surveyed and to be commenced during the current season :—		
Northern Division, ...	35	
Upper Central Division,...	20	
Lower Central Division, ...	30	
Etawah Terminal Division, ...	200	
Cawnpore Terminal Division, ...	180	
	——	465
Grand Total, ...		857½

22. In consequence of the re-arrangement of the limits of Divisions that had effect from the 1st November 1854, the Rajbuhas of the 2nd Division, between Asufnugger and Jowli, were transferred from the 2nd, or

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* The spring crop.

Upper Central Division, to the Northern Division, but it was considered expedient to leave the whole in the hands of Mr. F. Read, by whom the works had been originally laid out. This Officer's progress however did not come up to my expectations. I had hoped that some portions of his lines would have been ready for the Khureef of 1855-56, but none were As Mr. Read has been made fully aware of my disappointment, I need say no more on the subject here[illegible]ept to mention that he has now opened 167½ miles for the current Rubbee.

23. It will be observed from the map that all the blue lines are concentrated in the Lower Central Division under the superintendence of Lieutenant T. C. Merrick, whose success has even exceeded my expectations, as he had admitted water into 225 miles of Rajbuhas and Rajbuha Escapes during the course of the Khureef under notice. I can expect no more from Divisional Officers than that they should bring the water to the home-steads of the Zemindars under the most favorable conditions for distribution over the fields, but the actual consumption of the water in irrigation must depend mainly on the Zemindars themselves, and can only be indirectly promoted by the arrangements of the Canal Officers. All that could be done however to the latter end was most judiciously and satisfactorily effected by Lieutenant Merrick.

24. The results are exhibited in Appendix I to this Report,* which gives a nominal roll of villages, from which applications for water were received during the course of the Khureef. The total number was 48, and the aggregate quantity of water applied for was 266 Pymanahs,† on contracts for one year. The average quantity applied for by each village was a little more than half a Pymanah, indicating the extreme caution with which the Zemindars have begun to use the water. I consider this a satisfactory indication, as it gives grounds for hoping that the water being issued by volume will lead to great economy in its application, by giving the cultivators a strong interest in making the utmost possible use of the quantity they purchase. Ultimately this will be quite as much to the Government interest as their own.

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* Not printed.—*Ed.*

† Pymanah is the standard water-measure established on the Ganges Canal. It "consists of that quantity of water which flows in one second of time through a rectangular opening, one foot in length by four-tenths of a foot in height, under a constant head pressure of three-tenths of a foot measured from the upper edge of the opening." This is very nearly one cubic foot and a third per second.—*Ed.*

25. For reasons which were explained in detail in my letter, No. 1,643 A dated 15th September last, to the Secretary to Government, North-Western Provinces, and of which by far the most influential was the incomplete state of the Terminal Division Works, particularly those of the 5th Division under Captain F. Whiting, Lieutenant Merrick found that he could not maintain a supply of water of sufficient depth to fulfil satisfactorily the conditions of his contracts, and I accordingly recommended that the letter of such contracts should not be enforced, but that water rates should be claimed only on land actually watered, even in cases where the full supply had been maintained by the Canal Officers though not made use of by the cultivators. This recommendation was approved of by the Lieutenant-Governor, and I am quite certain that such an act of consideration has had an excellent effect. It makes the actual water rate of the Khureef however little more than nominal.

26. The following Statement shows the aggregate Revenue of the Ganges Canal for the period under review :—

Statement of Revenue derived from the Ganges Canal during the Khureef of 1855-56.

DIVISION.	Water rates and Tuccavee collections.			Mill rent.			Canal bank produce and miscellaneous.			Transit dues.			Divisional totals.		
Northern, ...	0	0	0	895	1	0	471	9	7	1224	8	0	2591	2	7
Upper Central, ...	0	0	0	13	4	0	610	14	3	0	0	0	624	2	3
Lower Central, ...	4119	6	3	153	6	9	1083	6	2	0	0	0	5356	3	2
Cawnpore Terminal, ..	Unremunerative.														
Etawah Terminal, ...	Ditto.														
										Grand Total,.. ..			8571	8	0

The detailed Statements from which the above abstract has been compiled are attached as Appendices II. III. and IV*. Of the grand total above shown, Rupees 7,710-9-9 are Revenue, and Rupees 860-14-3 Tuccavee collections.

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* Not printed.—*Ed.*

27. The total value of the water applied for during the Khureef was 3,258-8-0. The value of that utilized was Rupees 144-14-2; hence the amount remitted in consideration of deficient supply and inexperience of the people in practical irrigation was 3,113-9-10. How far the latter cause operated may be inferred from the fact that, on complaints being received that the water would not run in the village water-courses, the levels of several were taken by Lieutenant Merrick, and it was found in every case that the channel beds sloped the wrong way. Measures have now been taken to assist the Zemindars in laying out their water-courses properly, and I have no doubt they will soon learn to avoid errors of this kind.

28. The very moderate results of the first irrigating season of the Ganges Canal are in strict accordance with our experience in all other cases. The Eastern Jumna Canal shows a Revenue of about Rupees 4,000 during its first Khureef, of which water rates supplied Rupees 3,000. The Western Jumna Canals similarly show a Revenue from water rates at commencement of less than Rupees 900, but as on these Canals the growth of the Revenue was steadily progressive from year to year, so I believe it will be on the Ganges Canal also.

29. To illustrate this point I annex, as Appendices V VI. and VII,* Nominal Rolls of villages that have already applied for water during the current Rubbee. The general results are as follows:—

	No. of Villages.	*No. of Pymanahs applied for.*
In Northern Division, ...	12	23·2
In Upper Central Division, ...	43	51·1
In Lower Central Division, ...	52	29·41
Total, ...	107	103·71

The number of villages on the Roll for the Rubbee has therefore increased from 48 to 107, and the quantity of water applied for from 26·6 to 103·71 Pymanahs. The applications however are limited to the Fussil† only, and for the present single Fussil contracts are evidently in favor with the Zemindars; when their confidence is increased they will doubtless extend the periods to the limits allowed by the Rules.

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* Not printed.   † Half-yearly crop.

30. The principle on which the charges for water were fixed being to have low rates and large areas of irrigation, it has been satisfactory to me to learn from all the Divisional Officers that the general opinion among the Zemindars is that the rates are very light. I consider it of great importance to the Revenue to encourage in all reasonable degree the surface spread of irrigation, for when once its advantages have been realized, the cultivation will cling to them tenaciously, and in course of time the Government will find that the water has so risen in value as fairly to authorize an increase to the rates of payment for it.

31. It was not until the Khureef was well advanced that any of the Canal flour mills were made available for the use of the community. The following were opened between August and October, *viz.* :—

The Kunkul Mills, - - - -	20	sets of stones.
The Asufnugger Mills, - - -	4	,,
The Chitourah Mills, - - -	4	,,
The Lullawah Mills, - - -	4	,,
The Bholah Mills, - -	4	,,
Total, -	36	,,

The following will be opened during the current Rubbee :—

The Bahadurabad Mills, - -	8	sets of stones.
The Mahmoodpoor Mills, - - -	4	,,
The Bailra Mills, - - -	4	,,
The Jowli Mills, - - - -	4	,,
The Dasna Mills, - - - -	4	,,
The Pulra Mills, - - - -	4	,,
The Simra Mills, - - - -	4	,,
Total, -	32	,,

32 As contractors hesitated much in taking the mills for determinate periods, it was considered expedient to work them at first under the direct management of the Canal Officers. This is neither an economical nor an efficient arrangement, but was a temporary necessity to exhibit the working capacities of the mills. Hereafter all mills will be rented by public auction as on the Jumna Canals, and I think there is every reason to hope that fair returns will be obtained from them all.

33. The bank produce and miscellaneous Revenue is that derived from the sale of grass, rent of small pieces of Canal land, and such fines as are carried to the credit of Government. It will not rise to importance until the plantations begin to yield timber fit for consumption, when I anticipate a considerable accession to the income of the Canal from this source.

34. The transit dues on navigation have hitherto been limited to the returns derived from Government boats plying on the Canal in the transport of earth and materials. The hitherto incomplete state of the locks south of Roorkee has limited the navigation to the line between the head of the Canal at Hurdwar and Roorkee. Now the locks and navigable channels are entirely completed in wood and iron work, &c., and I am not aware of any obstacle to the passage of boats from Hurdwar to within five miles of Cawnpore. Great difficulties have been experienced in bringing the navigable channels and lock machinery into easy working condition, and I cannot say yet that they have been all overcome, but the progress made is so far satisfactory, that I shall be able to report results with greater confidence at the close of the current season. Mr. James Finn, the Superintendent of Navigation, informs me that he has received orders for the transport of the following materials during this time:—4,00,000 maunds of boulders for the use of the Ganges Canal Works; 6,00,000 maunds of boulders for the use of the Road Department, Department Public Works; 2,09,104 cubic feet of lime for the use of the Ganges Canal Works on the Futtigurh Branch. I am not anxious that general transport should be undertaken until the various works have been fully tested, and Mr. Finn will effect this object during the current season, holding himself of course ready to receive any offers from private individuals that may be made. As explained in detail in my letter, No. 939 dated 7th July 1855, to the Secretary to Government, North-Western Provinces, my ultimate object is to place the whole private carrying trade on the Ganges Canal in the hands of private individuals, under a system of licenses for the boats, which will greatly simplify our transactions in this branch of Revenue.

35. The only other point on which any remarks are required from me at present is the collection of Tuccavee advances. I find this the most serious practical difficulty which has to be overcome. Annexed to this Report, as Appendix VIII., will be found a copy of the general instructions issued by me to Divisional Officers in anticipation of the

commencement of irrigation,* and by referring to paragraph 26, the provisions temporarily adopted for dealing with these advances will be found. The circumstances of the Ganges Canal are entirely different to those of the Jumna Canals as concerns their Rajbuhas, for while on the latter the system was not introduced at all till at least six or seven years after irrigation had begun, and thereafter grew with a slow and gradual growth, it has been formed at once and on a very large scale on the latter. The progress of irrigation on the Jumna Canals was therefore wholly uninfluenced by demands for repayment of Tuccavee advances, until its advantages had been felt for a considerable period and the demands first made were very moderate and well diffused. On the Ganges Canal every applicant for water finds himself called upon to repay Tuccavee advances before he has had any experience whatever of the benefits of Canal irrigation, and I have reason to think that such calls exercise a prejudicial influence in checking irrigation.

36. Rajbuhas are to villages dependent on Canal irrigation what wells are to those using well irrigation. An efficient masonry well will suffice for the irrigation throughout the year of about thirty Canal beegas of land, and its cost of construction may be averaged at Rupees 150. One Pymanah of Canal water will suffice similarly for about 300 Canal beegahs, and the demand for it on account of original cost of Rajbuhas is at present Rupees 350, which however is no more than a rough approximation, subject to future adjustment when the actual cost of delivering the water can be correctly ascertained. To provide for the above-mentioned area by wells would cost the Zemindars Rupees 1,500. Hence in point of fact the Tuccavee demand is extremely moderate, being between one-fourth and one-fifth of the cost of wells. The current expenses in both cases may be assumed as the same, although Rajbuhas have I believe the advantage over wells in these also. It is only relatively therefore that the demands for Rajbuhas can be obstructive, and their influence will be temporary. At the same time the question rises, whether it would not be to the direct interest of Government to relieve this check, and stimulate the remunerative use of all the water the Canal can supply, giving to the irrigators from the Ganges Canal an advantage similar to that enjoyed by those using the Jumna Canals, and suspending for a period the demand for the prime cost of the Rajbuhas. The consequences of such an indulgence would probably be a much

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* As these instructions are of a technical character they have been printed with only a limited number of the copies of this Report.—*Ed.*

more rapid demand for irrigation, and readier re-payment of the advances after the benefits of irrigation had been experimentally felt. Government would thus obtain a large direct Revenue from the water rates of the Canal in a shorter time, and would thereby be compensated for the loss of interest on the capital advanced, supposing such interest to be sacrificed, though it need not necessarily be so.

37. To present the above view for consideration in a substantive form, I will suppose that Government resolves to suspend all demand for the prime cost of Rajbuhas for three years from the time at which irrigation may commence upon them. Taking 100 miles of channel, the total cost thereof would at average rates be Rupees 50,000, on which the usual interest would be Rupees 2,500 per annum. Allowing one year for construction and three for work in irrigation, the capital invested in the 100 miles of Rajbuhas at the close of the latter period, principal and interest, would be Rupees 60,000. The delivery of water by Rajbuhas may be taken approximately at two Pymanahs per mile or 200 Pymanahs for 100 miles, and under existing circumstances, it is probable that the actual consumption might be estimated at one-tenth for the first year, two-tenths for the second year, and three-tenths for the third year. Were the check caused by immediate Tuccavee demands to be removed, it would I think be fair to anticipate that the consumption would be doubled, making the progression two-tenths for the first year, four-tenths for the second year, and six-tenths for the third year. The comparative results, assuming the irrigation to be two-thirds *Tor* or natural, and one-third *Dal* or artificial, would therefore be :—

With Tuccavee Demands.						Without Tuccavee Demands.				
Year.	Pergunnah.	Quantity.	Rate.	Amount.	Total Amount.	Pymanah.	Quantity.	Rate.	Amount.	Total Amount.
1st	20	14 Tor. 6 Dal.	220 150	3080 900	3980	40	27 Tor. 13 Dal.	2 0 150	5940 1950	7890
2d	40	27 Tor. 13 Dal.	220 150	5940 1950	7890	80	53 Tor. 27 Dal.	220 150	11660 4050	15710
3d	60	40 Tor. 20 Dal.	220 150	8800 3000	11800	40	80 Tor. 40 Dal.	220 150	17600 6000	23600
Total water rates in 3 years, Co.'s Rs., ...					23670	Total water rates in 3 years, Co.'s Rs.,				47200

The gain in returns from increased consumption of water would therefore be Company's Rupees 23,530—the loss from suspension of demand would be four years' interest on Rupees 50,000, or Rupees 10,000 in all, leaving a nett gain of Rupees 13,530. At the expiry of the period of suspension Tuccavee collections would proceed as usual, by such number of Kists as might be fairly proportioned to the capabilities of the villages concerned.

38. These calculations are palpably hypothetical to a considerable extent, and it might easily be that the rate of progressive increase of water-rate I have assumed would not be realized. Without claiming confidence therefore for the numerical results I have given, I still think they indicate that greater gain would accrue to Government from encouraging the consumption of water, than loss from suspending for a time its demand for repayment of advances.

39. The course proposed would solve or at least greatly simplify several embarrassing administrative questions connected with Rajbuhas. In a system that has grown gradually, like that of the Jumna Canals, no difficulties are found in distributing the costs among the associated groups of irrigating villages. In a system that has been created at once, like that of the Ganges Canal, there are no groups of irrigating villages to deal with, but only isolated communities who naturally hesitate in taking upon themselves responsibilities which cannot yet be strictly defined. After three or four years of irrigation however things would be changed. Groups of villages could be formed and all demands fixed with precision and certainty, and levied with far greater ease than at present. If Government should think fit to direct that in calculating the amount to be paid on each Pymanah recovery of Tuccavee interest should be included, I believe that the charge would still be so moderate as to meet with no serious objection. I do not think however that this point requires decision at present, nor do I seek a decision on the question of suspension until the current Fussil has expired, but I am anxious to bring it at once under His Honor's consideration, that I may be able to supply any further details he may wish for..

40. The costs of special Rajbuha establishments and repairs are quite as embarrassing to deal with under present circumstances as those of the original construction of the works. It would exceedingly simplify the whole system if I were authorized to manage it as an exclusively Government one for a certain number of years, and at the expiry of that period to distribute the aggregate expense of construction and

maintenance by a Pymanah rate, to be paid in moderate instalments. Agreements to this effect might be taken from all contractors for water, for I feel quite certain that contracts nominally limited in time will inevitably be continuous, if they are only fairly worked out on the part of the Canal Officers. Should the general principle therefore of temporary direct management of the entire system of Rajbuhas appear to His Honor to be admissible and expedient, I shall be quite prepared to arrange the details, which would then become very simple.

41. I am not yet in a position to say when, or what portions of the Cawnpore and Etawah terminal lines may be expected to become remunerative, but I am satisfied that neither Lieutenant Price nor Captain Whiting will lose any time. Both these Officers have still extensive works on their main lines to complete, but their progress in Rajbuha levelling and lining out has been satisfactory to me, and their work will be reported on in due course after my inspection of their respective divisions.

42. It may now be considered that the machinery of irrigation is fit for active work in the three upper Divisions of the Ganges Canal. An aggregate length of very nearly 400 miles of Rajbuha has been supplied with water, and about 450 miles more are in hand. The constant volume of the Canal is now about 3,000 cubic feet per second, and can be increased whenever necessary without difficulty. What has now to be done is to maintain this supply with such steady regularity as will secure for the Canal the confidence of Zemindars, and induce them to become dependent on it, instead of their wells, for their supplies of water; to help the people to overcome the many little difficulties and occasional prejudices with which a novel system has to contend at first, and finally to give such encouragement to the extended consumption of the water as experience may show to be expedient and justifiable. I have never entertained myself, nor would I for a moment lead Government to entertain, the hope that the Revenue of the Ganges Canal will spring up with any remarkable rapidity, but at the same time I hold confidently that, great as has been the expenditure on this imperial work, its ultimate financial success is scarcely less certain than that the Ganges River feeds its channels.

R. B. SMITH, *Lieutenant-Colonel,*

Director Ganges Canal Works.

SECOND REVENUE REPORT

OF THE

GANGES CANAL,

BEING FOR THE

RUBBEE SEASON OF 1855-56, OR FROM 1ST NOVEMBER 1855, TO 30TH APRIL 1856.

BY LIEUT.-COLONEL R. BAIRD SMITH,

Director.

THE Inspection Reports of Works, in the different Divisions of the Ganges Canal, already submitted by me for the information of the Hon'ble the Lieutenant-Governor, show so fully the progress that has been made during the year 1855-56 towards the completion of the still incomplete portion of the Main and Terminal Lines, that I need enter into no details on those points here. It will be sufficient to mention that, during the season under review, the water of the canal flowed continuously through 449½ miles of the main trunk and terminal branches of the canal.

2. The volume of water maintained during the season gave an average height of 6 feet on the Roorkee gauge, or approximately 3,000 cubic feet per second in the canal channel. There were no interruptions to the flow of this fine stream. There were scarcely even fluctuations in its surface level, and there have consequently been entire contentment on the part of the zemindars with the supplies furnished to them, much confidence in their permanency created, and not a single instance of failure of contract by reason of deficiency of water delivered.

3. The progress made in the extension of the main channels of distribution or rajbuhas has been marked and satisfactory. To present it at once to the eye, I annex, on the opposite page, two sketch maps, the one showing the condition of the distribution channels at the close of the Khureef, or on the 31st October 1855, and the other their condition at the close of the Rubbee, or on the 30th April 1856. The same

colors have the same meanings in each. The blue lines indicate irrigating channels, the thick red lines channels that will become irrigating ones before the close of the season next following that under review, and the dotted red lines channels that are in progress, though not so far advanced towards completion.

4. By comparing these two maps, the growth of the distribution system will readily be appreciated. The actual mileages of the three classes are as follow :—

Length of Irrigating channels on the 31st October 1855		225 miles.
Length of do. do. opened between the 31st October 1855 and 30th April 1856 :—		
In Northern Division	96 miles.	
In Upper Central do.	92½ ,,	
In Lower Central do.	22 ,,	
		210½ ,,
Total of Irrigating channels at close of Rubbee 1855-56, ...		435½ ,,
Length of channels in progress that will be opened before the 31st October 1856 :—		
In Northern Division	14 miles.	
In Upper Central do.	10 ,,	
In Lower Central do.	87 ,,	
In Cawnpore Terminal do.	125 ,,	
In Etayah do. do.	200 ,,	
		436 ,,
Length of channels in progress, but not expected to contain water till after the 31st of October 1856 :—		
In Northern Division,	68 miles	
In Upper Central do.	28 ,,	
In Cawnpore Terminal do.	125 ,,	
In Etayah do. do.	160 ,,	
		381 ,,
Total complete and in progress		1252½ miles.

In my Khureef Report, I mentioned that I anticipated having 167½ miles of rajbuhas opened during the Rubbee. The extent actually opened is 210½ miles. At the close of the Khureef, the whole length of rajbuhas complete, or in progress, was 857½ miles. At the close of the Rubbee, or six months afterwards, it had increased to 1,252½ miles, a result which, I am sure, will be considered most creditable to the diligence and energy of the divisional officers of the canal.

5. As the most convenient way of exhibiting the revenue results of the Rubbee season under review, I propose to show, first, what has been done in each Division separately, and afterwards, to collect and condense these details, so as to illustrate the action of the canal as a whole.

6. *I. Northern Division.*—The Northern Division is under the superintendence of Captain Edward Fraser, of Engineers, and the following Statement shows the results which this officer has obtained. It may be noted here, that irrigation commenced in this Division only with the Rubbee season of 1855-56, and that the rajbuhas attached to it, aggregating 96 miles in length, were opened from time to time in the course of the season as they were brought into working order. Hence, in all cases in which water could only be supplied at late periods of the irrigating season, fair allowances were made, and the charges equitably proportioned to the volumes actually issued. The extent to which this adjustment was carried may be seen at once from the fact that, while the total volume contracted for amounted to 156·55 pymanahs, that charged for was only 95·15 pymanahs, the money value of the difference being upwards of Rupees 4,600.

TABLE No. I.

Abstract Statement of Revenue from all sources in the Northern Division Ganges Canal, during the Rubbee season of 1855-56.

From sale of water.	From rent of mills.	From sale of Canal Bank produce, as grass, &c.	From Transit Dues.	From Fines.	Divisional Total.
7,136 4 0	2,805 6 6	1,750 5 4	1,419 6 8	57 11 5	13,169 1 11

7. Half a century hence, when the canal revenue is counted by lakhs instead of thousands of Rupees, and the people of the Doab have learned

to look to the canal only for the water their crops require, the experience of our first year of irrigation will be looked back to with a curious antiquarian sort of interest. In recording that of the Northern Division, I cannot do better than allow Captain Fraser to tell his own story in his own words. " When submitting," he says, " my Report on the Khureef of 1855-56, I had but faint hopes of being able to bring forward, on this occasion, such favorable Reports of irrigation, as I have now the pleasure to lay before you. On the 19th November 1855, but twelve applications, for 23 pymanahs 2 duswas of water, during Fussil Rubbee of 1855-56, had been received; the rajbuhas themselves were incomplete, the water had hardly been admitted into their channels, constant breakage and stoppages were to be anticipated (and did occur), the system of contract was untried, the people of the district were totally unacquainted with the use of water for irrigation (even from wells), the first 9 or 10 miles of each main rajbuha ran through such deep excavation that irrigation by natural flow could not be hoped for in that length, the surface of the country traversed by the two rajbuhas executed was largely intersected with sand hills (bhoor) and undulating ground, creating difficulties in laying out the village water-courses, and lastly, the village proprietors and cultivators (with the exception of some in the Pergunnahs of Poor and Mozuffernugger bordering on the irrigating districts of the Eastern Jumna Canal,) through ignorance, apathy, or inability, or possibly all three combined, would do nothing towards laying out or constructing their own water-courses, relying entirely on 'the Sirkar' to bring the water to the very fields it was to benefit. To these obstacles, I may add, that the Revenue Establishment was new to its work, that I was greatly crippled by the want of competent and experienced levellers, able to lay out properly the village water-courses (many of which were two or three miles in length,) and that the commencement of the excavation of the Futtygurh Branch Canal had drawn off a very large portion of the generally available labor.

" The system of contract laid down by you has been rigidly adhered to by me, the only deviation (if deviation it can be called) that has unavoidably occurred being the substitution of wooden for masonry *kolabahs.** This was absolutely necessary, as the latter not only could not have been built, but in some cases it would have been a vexatious expense to have constructed them, as at first (owing frequently to the obstinacy of the zemindars in insisting on improper location), there was often occasion to remove the kolabahs to sites more favorable than those originally selected. However, the water has been measured out with tolerable accuracy, and where irrigation took place from an early period of the season, and the ground was favorable, the contractors appeared to be quite satisfied with the conditions of their bargain, and with the irrigating power of the allotted opening."

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* Conduits of wood or masonry.

8. This extract will suffice to show the circumstances under which irrigation commenced in the Northern Division. In spite of all difficulties, the nominal roll of the Division shows 134 irrigating villages, and the aggregate area of land watered during the season may be estimated at 18,507 canal beegahs, or 11,567 acres. According to the usual ratio that irrigated land bears to unirrigated in villages using canal water, the area of cultivation which has come under canal influence in six months may be estimated in the Northern Division at 56,000 beegahs or 35,000 acres.

9. The miscellaneous items of revenue in the Northern Division call for very few remarks. Captain Fraser finds the mill rent of the Division less than he anticipated. The most important corn mills are those at Kunkul, near Hurdwar. They consist of twenty sets of stones and they rent low, because of the severe competition they have to sustain with native mills in the immediate vicinity, the owners of which make no payment to Government for the water-power they obtain, though that is derived entirely from the canal water in the Myapoor Dam Escape Channel. The circumstances under which these water mills have been established, require further investigation, however, before I can adopt Captain Fraser's suggestion that they should hereafter work under licenses from the Superintendent of the Division, and the necessary enquiries will at once be set on foot. The returns from mills will however gradually, though it may be at first but slowly, increase as their convenience is appreciated. The revenue from transit dues on boats or rafts will be noticed hereafter when the work of the Superintendent of Navigation is reviewed. The bank produce has been judiciously disposed of, and I am glad to see that the amount realised by fines is very small.

10. I have great pleasure in expressing my warm recognition of Captain Fraser's exertions during the period under notice. For a commence-

ment of active work in irrigation, I consider the results he has obtained as satisfactory and encouraging, and to him personally the merit is almost exclusively due. He brings prominently to my notice, however, the valuable assistance he has derived from the administrative tact and conciliatory influence of the zillahdar of the Division, Moonshee Gholam Abbas, and as the duties discharged by this officer have entailed an unusual amount of field work upon him, I have considered myself justified in making him a donation of Rupees 100 as a mark of my approval of his activity and zeal.

11. *II. Upper Central Division.*—This Division is under the superintendence of Mr. Frederick Read. In it, as in the Northern Division, irrigation was commenced only with the Rubbee under review. The rajbuhas, aggregating 92½ miles in length, were opened similarly from time to time, and the conditions of the two Divisions were generally very much the same. The following Statement exhibits the results in the Upper Central Division :—

TABLE No. II.

Abstract Statement of Revenue from all sources in the Upper Central Division Ganges Canal, during the Rubbee season of 1855-56.

From sale of water.	From rent of mills.	From sale of Canal Bank produce.	From filling Tanks and watering Cattle.	From Fines.	Divisional Total.*	Tukkavi Collections.
9,376 3 10	359 1 6	2,053 12 11	25 7 1	60 10 0	11,875 3 4	1,805 1 10

12. The revenue from sale of water, as shown in this Table, consists of two separate items, *viz.* Rupees 3,737-8 for water issued under contracts, and Rupees 5,638-11-10 for water issued under measurement rates for area of irrigation. The water, in both cases, was supplied from the regular rajbuhas, and will be distinguished hereafter as "Direct Canal Irrigation," while "Indirect Canal Irrigation" will be used to

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* Under date the 26th June, Mr. Read reports that the whole of the revenue due in his Division had been then paid into the Treasury.

designate that from escape rivers. The circumstances under which Mr. Read allowed direct canal irrigation otherwise than under contract will best be explained by himself. "I was only induced," he observes, "to allow this method of irrigation in consideration of the inexperience of the zemindars, knowing full well, that when they had once commenced irrigation under either system, they would very soon find out which of the two was most to their advantage, and would eventually resort to the fixed module. Another reason which induced me to dispense with regular contracts and the specification of a fixed quantity of water by the zemindars without reference to the area irrigated was, that this being the first season they have had an opportunity of using canal water, their patches of Rubbee cultivation were so situated that, in many instances, but a few fields could derive any advantage from the rajbuhas. The zemindars seemed rather inclined, in those circumstances, to forego the advantages of irrigation in preference to entering into a contract for a fixed volume." I am not at all disposed to deny the force of these reasons, but the same difficulties were met with in the Northern Division, and yet no necessity arose for compromising there the essential principle of the Ganges Canal system of distribution. In the belief, however, that the compromise in the Upper Central Division will be a very temporary one, and there being no doubt that under it the price of water is at least 30 per cent. higher than under contracts, I do not think that any harm will follow.

13. Mr. Read's personal energy has been conspicuous in the way he has met the other difficulties of commencing work. "I was perfectly well aware," he observes, "that the construction of private water-courses was never intended to fall on the canal establishment, but from the utter inability and inexperience of the zemindars, I am of opinion that, had we not taken the supervision and construction of these works under our charge, the results of the last half, small as they are, would not have been one-third so large." Having undertaken this task, Mr. Read reports that 123½ miles of village water-course were completed by the regular canal establishment during the season. These seem to have been very economically executed, as the cost was only Rupees 23-5-2 per mile, giving a rate of about one anna per beegah on the land irrigated by one pymanah of water. The maintenance of the new rajbuhas and the training of a new establishment were satisfactorily and creditably done

by Mr. Read. He brings to my notice, in very favorable terms, the exertions of Zillahdar Mahommed Sadeek, whose activity in the field was valuable. In consideration of the unexpected extent of this work, I have directed that a present of Rupees 50 should be given to the zillahdar.

14. The Nominal Roll of Irrigating Villages in the Upper Central Division shows the following results :—

Contract villages	54
Measurement ditto	77
Total on Roll	131

15. The quantity of water issued and charged for by volume was 49 pymanahs 5 duswas. The area subject to measurement rates was 9,648 beegahs 2 biswas. The total area irrigated during the Fussil under review in this Division may be estimated at 19,548 beegahs 2 biswas, or about 12,200 acres. The area of cultivation for which the ordinary provision for watered crops has been made, may be taken at 58,000 beegahs or 36,000 acres.

16. The miscellaneous revenue of the Division need not be dwelt on long. There are but two sets of mills in it, and neither of these is favorably situated for profitable tenancy. Contractors have therefore been difficult to find, but both mills are now rented and produce Rupees 2 per diem each. It is not expected that this item will increase much, if at all. The canal bank produce has been creditably managed and disposed of, and Mr. Read mentions that, having succeeded in renting the grass on the banks to contractors from the nearest villages, cattle trespass has materially diminished, these men acting as a police for the protection of what is temporarily their own property. Filling village tanks is at present a small item, but it is thought it will increase. Fines also are petty in amount, which is satisfactory.

17. A beginning has been made in the recovery of Tukkavi advances for construction and maintenance of rajbuhas, but as I shall have something more to say on this subject in my general remarks, I may merely note the fact of such recoveries having been made in this place.

18. With the single qualification, that I would have been better satisfied by the maintenance of the principle of contracts in its integrity, I consider the results obtained during the Rubbee of 1855-56 to have been very creditable to Mr. Read and his subordinate officers.

19. *III. Lower Central Division.*—This Division is under the superintendence of Lieutenant T. C. Merrick, 3rd N. I. At the close of the Khureef, it had 225 miles of rajbuha channels ready for work during the Rubbee, and 22 more were opened during the season. So far as the condition of the Canal works and establishment was concerned, the difficulties were less than in either the Northern or Upper Central Divisions. But with the people they were probably greater, as it is noticeable that the farther we recede from existing Canal districts, the greater shyness and timidity do the zemindars show in taking the Canal water. There is an induced effect, so to speak, exercised by the Eastern Jumna Canal districts on others near them, which is stimulating to irrigation, and its force diminishes directly with the distance from them. Of course this will be but a temporary action, yet at first it is apparently a decided one. The following abstract shows the results obtained in the Division under notice:—

TABLE NO. III.

Abstract Statement of Revenue from all sources in the Lower Central Division Ganges Canal, during the Rubbee season of 1855-56.

From sale of water.	From mill rent.	From sale of Canal Bank produce, &c.	From filling Tanks.	From Fines.	Divisional Total.	TUKKAVI COLLECTIONS.			Total Tukkavi.
						For construction of Rajbuhas.	For repairs.	Miscellaneous.	
8331 13 10	47 14 3	310 12 3	5 10 3	275 2 10	8971 5 5	1391 9 3	1405 1 6	851 12 0	3648 6 9

20. The revenue from sale of water in this Division consists of two distinct items—*first,* Direct Canal Irrigation, amounting to Rupees 3,963-8-1, and *second,* Indirect Canal Irrigation, amounting to Rupees 4,268-5-9. The former is derived exclusively from sale of water by

volume under contracts, the latter from rates imposed on measured areas of irrigation. These rates were fixed at only one-half of those obtaining on the Jumna Canals, as the supply from the rivers connected with the Ganges Canal was supposed at first to be precarious. In point of fact, however, it has proved to be certain, abundant and regular, so that the rates press with exceeding lightness on the cultivation. It has now been ruled by the Hon'ble the Lieutenant-Governor, that when Indirect Canal Irrigation can be supplied under guarantees for its continuance and sufficiency, full measurement rates will be chargeable, and that partial rates regulated in amount by the number of waterings actually given to the land only should be imposed when the supply is intermittent.

21. The Nominal Roll of the Lower Central Division shows the following general results:—

Villages using Direct Canal Irrigation under Contracts, ...	104
Ditto using Indirect Canal Irrigation under measurement rates, ...	340
Total of Irrigating Villages, ...	444

22. The area of watered land in this Division, during the Rubbee, was 25,009 beegahs 14 biswas, or 15,631 acres, of which 8,076 beegahs 1 biswa, or nearly 5,047 acres, belonged to contract villages, and 16,933 beegahs 13 biswas, or 10,584 acres, to villages bordering on escape rivers. The area of cultivation, duly provided with its fair proportion of watered land, may be estimated at about 75,000 beegahs or 46,875 acres.

23. The quantity of water issued by volume was 58·16 pymanahs, and the area irrigated thereby having been measured in great detail, its aggregate amount was, as given above, 8,076 beegahs 1 biswa. The irrigating capacity of one pymanah during the Rubbee was, therefore, on the average of 104 villages, 139 beegahs 5 biswas, say 140 beegahs. The rate per beegah over all was accordingly 8 annas 6 pie or 3 annas 6 pie less than on the Jumna Canals.

24. The very complete manner in which Lieutenant Merrick has submitted his revenue papers enable me to illustrate the points noticed

in the last para. in detail, as well by average, and the following gives a condensed view of the results :—

TABLE NO. IV.

Abstract of Areas irrigated by one duswa (one-tenth of a pymanah) of water and cost of irrigation per beegah (of 3,025 square yards) as deduced from standard outlets of various dimensions in the Lower Central Division Ganges Canal.

Volume of water issued.		I. IRRIGATION NATURAL.								
		Area actually watered by one duswa.						Cost of Irrigation per Beegah.		
		Max.		Min.		Mean.		Max.	Min.	Mean.
P D	P D	Beeg.	Bis.	Beeg.	Bis.	Beeg.	Bis.	Rs. A. P.	Rs. A. P.	Rs. A. P.
+ 0 1	— 0 5	30	10	14	0	19	14	0 8 5	0 3 11	0 6 8
	0 5	23	10	11	13	16	14	0 10 0	0 5 0	0 7 8
+ 0 5	— 1 0	29	15	22	0	26	9	0 5 1	0 4 0	0 4 5
	1 0	17	7	11	15	16	15	0 10 0	0 7 0	0 8 4
	2 0	18	18	16	18	17	15	0 7 0	0 6 3	0 6 9
		II. IRRIGATION ARTIFICIAL.								
+ 0 1	— 0 5	25	13	12	17	16	16	0 6 3	0 3 4	0 4 6

NOTE.—The prefix — indicates "less than," that of + "more than."

25. It is impossible to attach much importance to data obtained during only six months' experience. Still so far as those given in the Table can be depended on, their indications are satisfactory. Leaving out the figures in the third line of the Table, which are extreme, and indicate some unusual conditions for the two or three outlets from which they have been calculated, the others show a fair correspondence in their mean results as regards the irrigating power of the pymanah, which ranges from 167 to 197 beegahs. On this point, Lieutenant Merrick remarks :—"The pymanah has been found, under ordinary circumstances, to irrigate more than 150 beegahs, and under favorable circumstances, it has been found to water nearly double the area specified. There are doubtless some instances in which it will be found that the pymanah has irrigated less than 150 beegahs, but the failure has been caused

either by the lateness of the date on which the contract was taken, or from the stupidity of the contractors themselves, who, in cases of Dal (artificial) irrigation, invariably try, in the first instance, to irrigate their land by Tor (natural flow,) and only when experience has shown them that the water will not run up-hill, do they take artificial means of raising it to their fields."

26. It is pretty clearly indicated in the Table, that water taken in small quantities is used with more economy, and is made to do more work than when taken in large volumes. The maximum working power of the pymanah, if estimated from outlets discharging less than 0·5 pymanahs, would be 310 beegahs, if from outlets discharging 2 pymanahs only 189 beegahs. These, however, are merely indications, and it will require long and large experience to give any positive proof on such a point as this.

27. As regards "Dal" or artificial irrigation, the working power of the pymanah seems to be almost the same as with "Tor" or natural irrigation. The maximum is very high, being 256¼ beegahs, and the mean is about 168. On the whole, the feeling of the irrigating community seems to be fairly expressed by Lieutenant Merrick, when he reports that "the contractors appear to be thoroughly satisfied with their contracts, for in no instance have I had complaints of the rates pressing heavily on them."

28. The grounds of this satisfaction will be more apparent if attention be given to the columns of the Table indicating the "cost of irrigation." Not even, in the most extreme cases, do the maxima rise to the level of the ordinary measurement rates of the Jumna Canals, while the mean cost is only a very little more than half these rates. It will further be evident from these columns, how powerful is the stimulus to careful and economical use of the water under a contract system. The best irrigator may have his land watered at a cost of 3 annas 11 pie per beegah, while the worst has to pay 10 annas for the same work. The gradations between these extremes are of course many, but the evident tendency of the system is to encourage careful irrigation by pecuniary rewards, and to discourage careless irrigation, by serious pecuniary losses.

29. The true market value of the water, as determined by free sale among the people themselves, is a point regarding which I have been

anxious to obtain information. Rule VIII., permitting the sale of surplus water by contractors to any purchasers not belonging to their own villages, was established partly to facilitate the collection of such information, and in Lieutenant Merrick's Division, it has been so employed. In these sales, which must be reported to the Canal officer, the general rule is to adopt the Canal rates, but several cases have occurred in which these have been increased, though not one in which they have been diminished. The following are exceptional rates which have prevailed:—

For single waterings per beegah, from	Rs. 0 5 0	to	0 8 0
For double ditto ditto, from	„ 0 12 6	„	1 0 0

Now as full irrigation from the Canal means four complete waterings during the Fussil Rubbee, the above sales give rates for the whole season, varying from a minimum of Rupees 1-4 to a maximum of Rupees 2 per beegah. Taking the irrigating power of a pymanah at the average of the whole Lower Central Division, or 140 beegahs, the cost of that volume of water, according to the results of these sales, ought to be from Rupees 185 to Rupees 280, or say an average of Rupees 230. The actual charge for it made by Government is Rupees 75, less than one-third of what it would bring in free sale. Without attaching any undue importance to data which, as yet, are far too limited to be confided in, it is still I think very clear that we have before us, in the future, a broad margin for increase of rates, without risk of checking the consumption of Canal water or pressing on the fair profits of cultivation.

30. The indirect Canal irrigation is distributed as follows:—

	Irrigating Villages.	Total Area of Irrigation.	
		Beeg.	*Bis.*
From Escapes connected with Rajbuhas	41	2,560	19
„ Tanks and Jheels filled by ditto...	92	2,817	0
„ the Kurroon Nuddi, ...	55	5,109	4
„ the Kalee Nuddi, ...	141	9,155	11
„ the Choya Nuddi, ...	11	290	19
Total, ...	340	16,933	13

The average rate on this irrigation has been, as nearly as possible, 4 annas per beegah, the same amount as is paid in the Agra and Delhi Districts for simple submersion of the land preparatory to the Rubbee, but without any subsequent irrigation. The areas irrigated in some of the villages are very large, ranging above 700 Canal beegahs,* while areas of 2 and 300 beegahs are very common. I have no doubt, indeed, that the ability to make use of these escape rivers has been a great boon to the people, while the proceeds have been a direct gain to the Canal revenue, likely I believe to grow yearly in amount and importance.

31. The miscellaneous revenue in the Lower Central Division is small. Mill rent does not produce so much as it ought to do, but the mill machinery seems to have been badly put up, and the mill-houses to be subject to frequent accidents. These difficulties, however, are reported by Lieutenant Merrick to be at an end now, and he anticipates a better revenue from his mills during the current season. The Canal bank produce return disappoints me, as I had expected it to be considerably larger. Fines are heavier in this Division than elsewhere, but it is the only one in which the Superintendent has carried out my instructions regarding the enclosure of the Canal works within strong hedges, and as these exist to a considerable extent, trespass becomes a readily punishable offence. Breaches of the Canal rules for irrigation seem to be the chief misdemeanors, and these must increase as our irrigation extends. It is, however, perfectly understood by divisional officers, that fines are a source of revenue, the increase of which is a cause of no satisfaction to me.

32. In this Division the Tukkavi collections have been comparatively large, amounting, during the Rubbee, to Rupees 3,648-6-9. These, however, call for no comment in this place.

33. The revenue work of Lieutenant Merrick has been done with his usual laborious care, zeal and interest, and I regret most sincerely that severe illness will deprive me of his valuable assistance for a long time to come, as he is obliged to proceed to England on medical certificate.

34. *IV. Cawnpoor Terminal Division.*—This Division is under the superintendence of Lieutenant George Price, 2nd E. F. During the Rubbee under notice, it was open for water throughout 165 miles of its length, but none of its distribution channels had been quite finished.

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* The Canal beegah is five-eighths of an acre and contains 3,025 square yards.

Means, however, have been found to bring a very considerable amount of land under irrigation, and the revenue shows very favorably for a Division in which so few facilities for irrigation yet exist. The following abstract shows its amount :—

TABLE No. V.

Abstract Statement of Revenue from all sources in the Cawnpoor Terminal Division Ganges Canal, during the Rubbee season of 1855-56.

From sale of water.	From sale of Canal Bank produce, &c.	Divisional Total.
5,980 3 1	309 3 0	6,289 6 1

35. As in the case of the Lower Central Division, the revenue from sale of water in the Cawnpoor Division is derived from direct and indirect Canal irrigation. As the former, however, was carried on by temporary means from rajbuha heads or other outlets, measurement rates have necessarily been adopted in charging for it, and no contracts have yet been made in this Division. The amount of revenue thus obtained has been Rupees 1,250-0-3, while the indirect irrigation from rivers fed by Canal water has amounted to Rupees 5,039-5-10.

36. The village nominal roll of the Division shows the following results :—

Villages irrigating directly from the Canal	78
Ditto ditto indirectly ditto	266
Total of irrigating villages	344

37. The area irrigated amounted in all to 22,295 beegahs 19 biswas and 11 biswansees, or nearly 13,935 acres. The distribution of this was as follows :—

Direct Canal irrigation, ...	3,113	19	7
Indirect ditto ditto from the Eesun River,	5,078	6	4
Ditto ditto ditto from the Kaleè River,	14,103	14	0
Total irrigated area	22,295	19	11

The average rate on this extent of irrigation has been the very moderate one of 3 annas 7 pie per beegah, or nearly 5½ annas per acre. The total area of cultivation, influenced by the Canal irrigation in this Division, may be estimated, in round numbers, at 65,000 beegahs, or about 40,000 acres.

38. The miscellaneous revenue is limited to the proceeds of sale of bank produce. It is in fair proportion to the capabilities of the Division.

39. I consider the results of the Rubbee as very creditable to Lieutenant Price's administration, and I have no doubt that, when his rajbuhas come into play (as it is hoped they will during the current Khureef for a length of about 125 miles), the revenue of the Division will show a marked increase. Meanwhile, no Division, unprovided with rajbuhas, has shown results at all comparable with those attained in the Cawnpoor Terminal Division.

40. *V. Etayah Terminal Division.*—This Division is under the superintendence of Captain F. Whiting, of Engineers. Its conditions are very similar to those of the Cawnpoor line, excepting that it had, during the Rubbee, only 103 miles of open Canal channel. There has been a great contrast in the extent to which the Canal water has been made use of, as the following abstract will show :—

TABLE NO. VI.

Statement of Revenue from all sources in the Etayah Terminal Division Ganges Canal, during the Rubbee season of 1855-56.

From sale of water.	From sale of Bank produce, &c.	Divisional Total.
560 4 8	24 6 0	584 10 8

41. The revenue from sale of water is, as before, in two items—*first*, Rupees 80-15-8 for direct, and *second*, Rupees 479-5-0 for indirect Canal irrigation.

42. The area irrigated amounts to 2,484 beegahs 17 biswas 7 biswansees, of which 189 beegahs 17 biswas were watered from the canal, and 2,295 beegahs and 7 biswansees from the escape rivers of the Division. The cost of irrigation has been only 3 annas 2¼ pie in this Division, and the total area of cultivation, influenced by the canal, may be estimated at about 7,500 beegahs, or nearly 4,700 acres.

43. The miscellaneous revenue is insignificant and requires no comment. As, however, it is hoped, that about 200 miles of rajbuhas will be opened for work during the current Khureef, my next Revenue Report on the Etayah Division will, I trust, show larger results.

44. *VI. Navigation Department.*—This department of the canal operations is under the superintendence of Mr. James Finn. During the Rubbee the strength of the fleet employed was 103 wooden boats of 200 maunds burden and 86 iron boats of about 100 maunds each. Of the former 21 were permanently at the disposal of the Superintendent of the Northern Division for the completion of the head-works of the canal, on which the maintenance of the supply depends, and various miscellaneous work, with accidents and contingencies, absorbed about 30 more. The number of boats regularly employed throughout the season by Mr. Finn was about 120. The navigable channels, however, were found to work somewhat unsatisfactorily, and a great deal of trouble was required to bring them into efficient order. Hence navigation generally was carried on with considerable interruptions, which however are not likely to recur. The work of the boats was, under these circumstances, restricted to the transport of materials for the Public Service, as till transit had been made easy and secure, it was not considered expedient to invite private traders to make use of the canal, lest the unavoidable checks should discourage them. I think, however, that the time has now come, when the canal may safely be made available for general use, and arrangements are in progress for notifying the same.

45. During the season under notice, the canal has been a good deal used by timber traders for the transport of wood. 143 rafts have passed down, and on two occasions merchants have hired Government boats for carrying hill produce from Hurdwar to Sirdhanna.

46. The following short Statement will give a general idea of the work done for the Public Service :—

	Maunds.		Tons.	
River stone for metalling the new road from Roorkee to Mozuffernuggur...	2,50,081	or	8,930	nearly.
Ditto ditto for the use of the works of the Ganges Canal	1,95,399	„	6,980	„
Stone lime for ditto ditto	14,753	„	527	„
Bricks for ditto ditto (4,07,000).........	80,000	„	3,850	„
Total, ...	540,233	„	20,287	„

47. The transit dues on the above amount to Rupees 1,419-6-8, but these give only an imperfect idea of the pecuniary results of using the canal for transport. The whole of the established rates for carriage of materials have been reduced, and the saving thereby effected during the last six months on the materials transported in the boats alone has amounted to the considerable sum of Rupees 15,460-12-11.

48. Preparations are now in progress for dispatching a large detachment of boats to Cawnpoor* to carry down all the wood-work and machinery required for the terminal locks on the Ganges, and to bring up iron for the work-shops. Another detachment is about to be dispatched to Allyghur, to bring up general stores, and it may be hoped that, when traders see the perfect ease and security with which boats traverse the canal, they, and also private proprietors of boats, will be induced to resort to it. No considerable traffic can, however, be looked for, until Lieutenant Price has finished the terminal works and so established an immediate connection between the canal and River Ganges. These works are rapidly approaching completion, and but for the very unexpected commencement of the rains, and the floods caused thereby, the water would already have been carried down to the city of Cawnpoor. At present it is turned off about 8 miles above that place.

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* Under date the 15th instant, Mr. Finn reports, that his fleet of 17 boats left Roorkee on the morning of the 9th, and reached Sirdhanna on the morning of the 11th instant, thus making 56 miles in two days, over a section of the canal in which there are six sets of locks to be passed.

49. Mr. Finn has carried on his work hitherto in the midst of difficulties, all of which he has met with intelligence and energy, and I have much pleasure in expressing my entire satisfaction with the measure of success he has obtained. I hope, however, it is but the index of far greater success to be attained hereafter.

TABLE NO. VII.

General Statement of Revenue from the Ganges Canal during the year 1855-56.

1855-56.	From sale of water.	From mill rent.	From Transit dues.	From sale of Canal Bank produce, &c.	From filling tanks and watering cattle.	From Fines.	Total of each fussil.	Grand Total of 1855-56.	Tukkavi collections in 1855-56.	Saving to works by use of canal for transit in 1855-56.
Fussil Khureef ...	3,258 8 0	1,061 11 9	1,224 8 0	2,165 14 0	0 0 0	0 0 0	7,710 9 9	0 0 0	860 14 3	0 0 0
„ Rubbee ..	31,384 13 5	3,212 6 3	1,419 6 8	4,448 7 6	31 1 4	393 8 3	40,889 11 5	48,600 5 2	5,453 8 7	15,460 12 11
Totals ..	34,643 5 5	4,274 2 0	2,643 14 8	6,614 5 6	31 1 4	393 8 3	0 0 0	48,600 5 2	6,314 6 10	15,460 12 11

50. Having now completed the details of the separate divisions of the canal, I proceed to give some others, which illustrate its work as a whole. The marginal statement exhibits the aggregate revenue of 1855-56, and it is interesting as showing the entire results of the first year of irrigation.

51. On grounds of equity in some cases, and of consideration for the total inexperience of the zemindars in others, the Honorable the Lieutenant-Governor was pleased to sanction remissions on the revenue of the Khureef to the amount of Rupees 3,113-9-10. No claims for such indulgence have as yet been brought for the Rubbee, so that the net returns, in direct revenue, for the year, may be taken at Rupees 45,487-1-7. If to this there be added the sum that has been saved by the use of the canal in aid of the works, the aggregate pecuniary return for 1855-56 is Rupees 60,947-14-6. Tukkavi advances, to the total amount of Rupees 6,314-6-10, have been

recovered from irrigators during the year, in addition to the general revenue.

52. The vast mass of accounts of expenditure that has to be reduced into manageable forms, before results in abstract can be exhibited, has not yet been completely classified. It is, however, far advanced towards completion; and I have every reason to hope that, before my next Report becomes due, I shall be in a position to perfect the series of statements necessary to show the financial condition of the canal, by giving a "Comparative Statement of Expenditure upon, and Receipts from, the Works."

53. The following Statement illustrates the extent to which the influence of the canal has been felt by the agricultural community of the Doab during the season under review :—

TABLE No. VIII.

Abstract of Divisional Nominal Rolls of Villages irrigating from the Ganges Canal, during the Rubbee of 1855-56.

Divisions.	I. DIRECT CANAL IRRIGATION.								
	No. of villages irrigating.			Effective Irrigation.				Proportions to each village.	
	By contract.	Area.	Total.	No. of pymanahs issued.	No. of beegahs watered under contract.	No. of beegahs watered under rates.	Total area of irrigation in each.	Of pymanah.	Of beegahs.
Northern	134	...	134	95·15	18,507	......	18,507	0·71	138
Upper Central	54	77	131	49·5	9,628	9,648	19,276	0·91	147
Lower Central	104	...	104	58·16	8,076	......	8,076	0·56	77
Cawnpore Terminal	...	78	78	...	......	3,114	3,114	...	40
Etayah Terminal	...	12	12	...	......	190	190	...	16
Total of Canal Villages	..	...	459	Total area of canal irrigation ...			49,163		
	II. INDIRECT CANAL IRRIGATION.								
Lower Central	...	340	340	...	......	16.034	16,934	..	50
Cawnpore Terminal	...	266	266	...	......	19,183	19,183	..	72
Etayah Terminal	...	69	69	...	......	2,295	2,295	..	33
Total of Escape River Villages ..			675	Total of Escape River Irrigation ..			38,412		
Grand Total of Irrigating Villages ..			1134	Grand Total of Canal Irrigation ..			87,575 Beegahs, or 54,734 Acres.		

54. When my last Report was submittted, 48 villages only had actually taken water, and 107 had applied for it. Within six months afterwards, the villages irrigating directly from the canal have more than quadrupled the number of applicants, while 675 additional villages have had sensible proof of the competency of the canal to supply their wants. At this stage of our progress, the number of village communities using the water is an index of deeper significance and higher value than the areas actually watered. It may be confidently assumed from all previous experience, that not one of these communities, having once discovered that it can have canal water plentifully and cheaply, will intermit its use till the whole irrigable land of the village has gradually been provided for, unless indeed mistakes should be made on our side. Hence I attach much interest and importance to the fact, that in a single season, upwards of 1,100 villages should have been supplied with canal water in quantities not insignificant, even on the average, and in a great number of cases of serious importance to the interest of the irrigators.

55. The influence of recession from the neighborhood of existing canal districts may, I think, be traced in the above Table. The two Northern Divisions of the Ganges Canal lie entirely within the districts of Saharunpoor, Mozuffurnuggur and Meerut, each having some of the best examples of successful irrigation that the Eastern Jumna Canal can show. Here the quantity of water taken by each village on the Ganges Canal varies from three-fourths to a whole pymanah, and the area of irrigation in each from 138 to 147 beegahs. The Lower Central Division lies mainly in the Boolundshuhur and Allyghur Districts, where no canal irrigation has ever before been known. Here the proportion of water drops to half a pymanah for each village, and the area of irrigation in each to 77 beegahs. I have little doubt that these results are, in some degree, though not entirely, due to the comparative knowledge of the people regarding the effects of pre-existing works.

56. The total area of irrigation, during the Rubbee, is shown to have been 87,575 canal beegahs, or 54,734 acres. Of this, very nearly the whole has been new irrigation, and much of the land has produced crops which have been so unusually abundant as to cause considerable local excitement and interest among the people themselves. Assuming that the common average difference in quantity of produce between irrigated

and unirrigated land has prevailed over 50,000 acres of the area watered by the Ganges Canal, the gain to the people from this source alone, during the Rubbee of 1855-56, will be found to be very nearly five lakhs of Rupees. The cost of this irrigation, including rajbuha expenses, has amounted to, as nearly as possible, 12 annas per acre, or 7 annas 4 pie per beegah, and had wells been employed, instead of the canal, the water from them would have cost certainly not less than 3 Rupees per acre, and probably considerably more. The cultivation of 50,000 acres of hitherto unirrigated land may, therefore, be held with confidence to have been equivalent to an increase of the agricultural wealth of the Ganges Canal districts, moderately represented by Rupees 6,00,000 for the Rubbee of 1855-56. It is no great matter for surprise, that under such circumstances, 1,134 villages should have come forward to share in so substantial a boon. The watered area of canal villages, being to that under dry crops usually as 1 to 3, the total area of cultivation, for which sufficient irrigation has been already provided, may be taken, in round numbers, at 2,60,000 beegahs, or 162,500 acres, which represent the whole superficial extent of country over which the influence of the Ganges Canal has been felt.

57. The last point connected with the results of the Rubbee, to which it is necessary for me to advert, is the information given by the nature and duration of the contracts entered into between the canal officers and the zemindars. The following Statement exhibits this in forms, which, I hope, will make its bearings distinct and intelligible:—

TABLE No. IX.

Classification of Contracts for water taken by Villages on the Ganges Canal, during the Rubbee of 1855-56.

Volumes of water supplied.	I. By volumes of water contracted for.								
	Northern Division.		Upper Central Division.		Lower Central Division.		Per-centages of each class of Contracts on Divisional Totals.		
	Tor.	Dal.	Tor.	Dal.	Tor.	Dal.	North Division Total 134.	U. C. Division Total 54.	L. C. Division Total 104.
P D P D									
+ 0 1 — 0 5	15	....	5	....	64	....	0·11	0·09	0·61
0 5	29	....	4	2	10	....	0.21	0·07	0·09
+ 0 5 — 1 0	4	....	4	....	11	....	0·03	0·07	0 10
1 0	45	....	24	1	6	...	0·33	0·22	0·05
+ 1 0 — 1 5	2	....	....	....	6	....	0·01	......	0·05
1 5	9	....	3	....	....	....	0·06	0·05	......
+ 1 5 — 2 0	1	....	...	....	....	....	......	.....	......
2 0	18	....	7	....	6	....	0·13	0·13	0·05
+ 2 0 — 3 0	3	....	1	....	....	....	0·02	0·02	......
3 0	4	....	2	....	1	....	0·03	0·03	.....
+ 3 0 — 4 0	2	....	1	....	....	....	0·01	0·02	......
4 0	2	....	....	....	....	.....	0·01	....	......
	II. By periods of Contract.								
For one Fussil -	101		54		104		0·75	1·00	1·00
„ 1 Year -	14		......		......		0·10	......	.. ..
„ 1½ Year -	1		......		......		......	.....	......
„ 3 Years -	18		......		......		0·15	......	.....

Note.—The prefix + means "more than;" — "less than."

58. This Table is an epitome of all the experience yet obtained on the operation of the contract system of the Ganges Canal. Taking the first section, in which the basis of classification is the volume of water issued, and grouping under the head of "small contracts," all for quantities less than one standard pymanah,* and under that of "large contracts," all for one pymanah and upwards, the several Divisions give the following comparative results:—

	Northern Division.	Upper Central Division.	Lower Central Division.
Small contracts	0·37	0·24	0·81
Large ditto	0·63	0·76	0·19

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* The standard pymanah is the quantity of water that passes with a free flow through an opening 1′ × 0′·4, under a head pressure of 0′·3. Its value is practically rather more than 1 cubic foot per second.

The Upper Central Division shows the greatest proportion of large contracts, 76 per cent. of the contracting villages having taken one pymanah of water and upwards. In contrast with this result, the Lower Central Division shows 81 per cent. of small contracts. The Northern approximates to the Upper Central Division, but is still a good deal below it. The general inference is the same as was previously drawn from the comparative area of irrigation, namely, that in receding from existing canal districts, smaller contracts preponderate.

59. Looking to the 2nd Section, in which the basis of classification is the duration of the contracts, the relative positions of the Divisions are changed in some measure. The Upper and Lower Central alike show nothing but single season or Fussil contracts. The Northern Division shows 75 per cent. of Fussil contracts and 25 of one year and upwards. This relative superiority in the latter Division will be still more marked at the close of the current season. Of the contracts completed up to the present date, 70 per cent. are for the full period of three years, and none are for less than one year. In both the other Divisions, short contracts, are still the favorites, indicating less confidence for the time being in the canal administration. As, however, a considerable number of annual contracts have been taken, both in the Upper and Lower Central Divisions, and as the volumes applied for have also somewhat increased, I have little doubt that the tendency of the people to long and large contracts is a growing one.

60. In paras. 36 to 40 of my Report on the Khureef of 1855-56, I adverted to the financial expediency of suspending, for a certain period demands for re-payment of Tukkavi advances made for the construction and maintenance of the rajbuhas of the Ganges Canal, and managing these works for the period decided on, as though they were the property of the State exclusively. Some further explanation on this point was called for in letter No. 2594 A., dated 18th December 1855, from the Secretary to Government, North-Western Provinces, and this was not supplied at once, because I was anxious to be able to bring some practical experience to bear on the question. The only point on which the rajbuha management differs from that of works the property of the State, is that the expenditure on the former is recovered from the villages consuming the water they supply, while that on the latter is carried in account to the debit of the State. The temporary assimilation of the two classes of works, by suspension of demands for re-payment of expenditure on rajbuhas, and the

debit of the same to the State during such suspense, was what I meant by the expressions "management of the whole system as an exclusively Government one," and "temporary direct management" in the Khureef Report.

61. The experience obtained during the Rubbee tends strongly to confirm my impression, that it would be a pecuniary gain to Government to suspend for, say at present three years, all demands for re-payment of Tukkavi advances. In the calculations I gave of the probable results of the course suggested, I was compelled to assume a certain rate of progressive increase of irrigation when relieved from Tukkavi demands, but there were no data accessible, by which the accuracy of that rate could be in any way verified. It was a mere guess, but it turns out to be consistent with the experience of the Rubbee. In the Northern Division no demands were made for re-payment of Tukkavi, and the Superintendent, with my concurrence, had intimated to the people, that he would not make them for that Fussil. The area of land irrigated was 18,507 beegahs. In the Lower Central Division, full Tukkavi demands were made, and the area of land irrigated subject to those demands was only 8,076 beegahs. I have already stated, that this difference may in part be attributed to the relative proximity of the Divisions to existing canal districts, but I have no doubt that the extension of irrigation on each was most materially influenced by the different courses pursued in reference to Tukkavi recoveries. I assumed that irrigation, free from Tukkavi demands, would spread twice as fast as when burdened with them, and from the experience of the Northern and Lower Central Divisions during the Rubbee, this rate is below the truth. In the former, 96 miles of rajbuha produced Rupees 7,136 from water rates; in the latter, 225 miles produced only Rupees 3,963. In the first case, I allow fully half of the results obtained to be due to the stimulating effect of the close proximity of the Eastern Jumna Canal districts, and still the revenue from 100 miles of rajbuha in the Division free from Tukkavi demands is to that from an equal length in the Division subject to these demands, as 3,719 is to 1,761, or as 2·1 to 1, showing that my original basis of calculation was a very fair one. That calculation showed that, at the close of three years after the suspension of Tukkavi demands, the clear gain to Government, from increased spread of irrigation, would be Rupees 13,530 on every 100 miles of working channel. Believing this result to be approximately cor-

rect, I can have no hesitation now in recommending to the Hon'ble the Lieutenant-Governor, that all demands for re-payment of sums expended on rajbuhas should be suspended till the 1st of May 1859, and that the aggregate expenditure up to that date should thereafter be recovered by such number of instalments or "kists" as may be equitable and expedient with reference to the circumstances of each contracting village. Should this proposal be approved of by His Honor, the necessary instructions in detail will be communicated by me to the Superintendents of Divisions.

62. I believe there are no other points connected with the results of the Rubbee, or of the year 1855-56, to which I need advert at present. I will only add, therefore, that the Ganges Canal closes its first year* of work with 449½ miles of main canal open for water, 436 miles of rajbuha channel completed, and 817 miles in active progress, with an aggregate revenue from all sources of somewhat more than Rupees 60,000, having watered during the year about 98,000 beegahs or 55,000 acres of land, and having placed beyond the risk of serious damage from drought an area of cultivation extending over about 2,65,000 begahs, or 1,66,000 acres, distributed among 1,134 villages. These results will equal, I sincerely hope, the expectations of Government from this great work at the present stage of its development. The prospects of the current Khureef, I am happy to say, are at present very promising, and there seems to be every probability of a material increase of Revenue from all important sources.

R. BAIRD SMITH, *Lieut.-Colonel,*
Director of the Ganges Canal.

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* Under date the 12th instant, Captain Fraser reports that, on the 19th of June, contracts had been completed in his Division for 176 outlets, and that 1,386 pymanahs, to the value of Rupees 20,790, had been actually supplied to villages for the current Khureef. This is nearly triple the Revenue from water-rates during the Rubbee, and the amount may possibly increase before the close of the season of irrigation.

Appendix No. 1.

The classification of Accounts, referred to in para. 52 of the Rubbee Report, having been completed, while the Reports for 1855-56 were passing through the Press, the following Account Current, showing in abstract the financial condition of the Ganges Canal on the 30th April 1856, has been added as an Appendix. It shows that the canal commences its career as a remunerative work, with a debt to the State of about 11 lakhs of Rupees, or £110,000, sterling. Of this sum, however, only about 4 lakhs, or £40,000, are for the current annual expenses, 7 lakhs, or £70,000, being for interest on capital at 5 per cent.

It seems probable that, within five or six years, the direct revenue of the canal will suffice to cover all current expenses for establishments and maintenance; and that thereafter the canal will commence to pay a gradually increasing interest on the capital sunk in its construction. It is to be noted, however, that three great branches, the Futtygurh, Bolundshuhur, and Coel, remain to be completed before the expenditure on original works can cease or the project be regarded as completely worked out. On the whole, it is my opinion now, as it has been for many years past, that the Ganges Canal will not be fully completed under very nearly two millions sterling.

R. BAIRD SMITH, *Lieut.-Colonel,*
Director, Ganges Canal Works.

ROORKEE,
28*th August* 1856.

APPENDIX.

Dr. *The Ganges Canal Dead Stock and Current Expenses in Account, with Returns thereof.* **Cr.**

	Original Works.			Contingent Expenses.			Total.		
Dead stock to 1st May 1855, *viz.*,—									
Original Works, ... 1,32,27,052-5-4									
Executive establishment and maintenance of works whilst constructing, .. 14,98,841-6-4									
Share of Director's Office expenses whilst works were constructing, - 2,48,313-5-2	1,49,74,207	0	10	...	..	...	1,49,74,207	0	10
Interest on above at 5 per cent., - -	..	..	..	7,48,710	5	7	7,48,710	5	7
Rajbuhas, Tukkavi advances, - -	5,92,285	7	2	...	...	...	5,92,285	7	2
Dead Stock for 1855-56, - -	6,39,180	2	7	...	...	...	6,39,180	2	7
Current expenses during 1855-56—									
Executive, - - Rupees 3,61,674-8-1									
Share of Central Office, - 39,584-11-10	..	..	..	4,01,259	3	11	4,01,259	3	11
	1,62,05,672	10	7	11,49,969	9	6	1,73,55,642	4	1
Deduct Dead Stock and Rajbuhas ... Co's. Rs.							1,62,05,672	10	7
Total, Company's Rupees ..							11,49,969	9	6

	Gross Revenue.			5 per cent. interest.			Total.		
Gross Revenue 30th April 1856, ...	48,600	5	2	0	0	0	48,600	5	2
Balance, being deficit on 30th April 1856,...							11,01,369	4	4
Total, Company's Rupees ..							11,49,969	9	6

R. BAIRD SMITH, *Lieut.-Colonel,*
Director, Ganges Canal Works.

CENTRAL OFFICE, CANAL DEPARTMENT,
NORTH WESTERN PROVINCES,
The 26th August 1856.

IRRIGATION IN LOWER EGYPT.

EXTRACT *from a Letter from* W. HART, ESQ. SECRETARY TO THE GOVERNMENT OF BOMBAY, *to* LIEUT.-COLONEL W. E. BAKER, *Secretary to the Government of India, dated the* 12*th June* 1856.

IN March last, it was suggested to Government, by the Chief Engineer of Public Works at this Presidency, that Captain Fife,* of the Bombay Engineers, then proceeding to England, should be requested to remain for a short time in Egypt, for the purpose of obtaining information respecting the new scheme of irrigation adopted in that country.

2. Having no doubt of Captain Fife's ability, for both obtaining such information, and turning it to account afterwards, the Right Hon'ble the Governor in Council was pleased, in compliance with Major General Waddington's suggestion, to authorize Captain Fife to remain on duty in Egypt, for a period not exceeding three months, for the purpose of making the necessary investigation.

3. I have now the honor, at the desire of the Right Hon'ble the Governor in Council, to forward copy of a communication from Captain Fife, dated 4th April 1856, reporting the result of his enquiries and personal examination, together with a Hydrographic Map (which it is requested may be returned to this Government,) of Lower Egypt and part of the Isthmus of Suez, showing the irrigational and navigational works in that country, executed or in contemplation.

4. I am directed to convey the request of the Governor in Council, that this Report of Captain Fife's may be placed before Lieut.-Colonels Baker and R. Baird Smith, for any observations which may occur to those Officers.

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* Whose outline project for improving the Canal irrigation of Sind was submitted with Mr. Secretary Hart's letter (No. 367), dated 21st February last.

LETTER *from* CAPTAIN J. G. FIFE, *Bombay Engineers, to* MAJOR GENERAL WADDINGTON, *Chief Engineer of Public Works, Bombay, dated Cairo, the 4th April* 1856.

Public Works Dept.

SIR,—Having spent a fortnight in Egypt, for the purpose of looking at the irrigation system, to ascertain whether there was anything in it, which might be applied with advantage to Sind, I have now the honor to lay before you the result of my examination.

2. The Nile in Upper Egypt has a rise of about 30 feet, and at Cairo, it is about 24 feet, from its lowest to its highest level. The slope of the bed varies from about 6 inches in Upper Egypt to 4 inches a mile in Lower Egypt. From Cairo to the sea, the fall, of course, varies with the quantity of water in the river. When the river is low, the total fall from Cairo is about 46 feet, or a little more than 3 inches per mile. During the inundation, the total fall is 71 feet, or 5 inches per mile. The last-mentioned fall, *viz.* 5 inches per mile, is of course the average slope of the plain from Cairo to the sea. The surface velocity of the stream, during the low season, has been observed to be 1·62 feet per second, and during the inundation 4·94 feet per second. The discharge, during the low season, has been calculated at 14,259 cubic feet per second, and during the inundation at 324,478 cubic feet per second.

3. As the banks of the Nile, from the first cataract to the sea, consist of clay and sand, the channel of the river is continually changing. These changes, however, are, at least in Lower Egypt, very slow· Bridges across the Canals are made within 200 or 300 feet of the bank of the river, and when an embankment is carried away by the encroaching stream, the new embankment is thrown up only 50 or 80 feet farther back.

4. The inundation commences at the end of June, but the river does not rise much till the end of July. During the low season, and, indeed, until the end of July, the water is tolerably clear; after that, it becomes of a brown color, and is heavily charged with rich fertilizing matter. The inundation is at its maximum about the 20th October, and sometimes later. In January, it decreases rapidly, and afterwards continues to decrease slowly till June, when it commences to rise again.

5. The Canals, with the exception of those designed by M. Linant Bey and M. Mongil Bey, the Pasha's Engineers, are most primitive in construction. Their general direction is good, but they are quite spoiled by the number of intermediate twists and turns. A few of them only contain a slender stream after the inundation subsides, and this is only obtained by excavating to a depth of about 25 feet. They are all provided with Regulating Bridges at their heads to regulate the supply of water. These, however, are modern, and generally consist of one central arch, of about 15 feet span, for the passage of boats, with smaller side arches. The supply of water is regulated by means of long baulks, placed in a perpendicular position against the up-stream face of the Bridge. In former years, I was informed that these Bridges frequently failed, and required re-constructing every three or four years. The banks of the Canals are generally sufficiently sloped, but they are by no means regular. The accumulation of silt on the banks, from the annual clearance, is much less than is commonly seen in Sind; but I think this results from the Nile being less charged with silt than the Indus, and not from any great superiority in the construction of the Canals. M. Linant Bey, who has been engaged with Canal works in Egypt for upwards of thirty years, informed me that he found that a surface velocity of 2½ feet per second was necessary to prevent the silt collecting in the Canals; when the inundation is at its height, and the water from the Canals has a ready escape on to the land, the stream through the large Canals is probably very swift.

6. The principal crop is the wheat, which is sown on the inundated land in November. During the remainder of the year, other crops are raised by irrigation, but they are small, compared to the wheat, which is extremely good. The plan practised at the head of the Delta, which I passed through, is as follows:—The banks of the river are embanked to a height of from 6 to 8 feet, the thickness at top varying from 8 to 20 feet, the broad embankments being used as high roads. In addition to these are other embankments, in every direction, dividing the country into large fields. When the Canals are full, cuts are made through their banks, and the fields enclosed by the embankments are flooded to a depth of 2 and even 3 feet, until the inundation subsides, when the water drains off the land into the Canals again. The wheat is then sown, and when the Canal near it contains water, the crop is irrigated by the wheel. During the inundation, very little irrigation and cultivation are

carried on. Rice and grain very much resembling jowarree, are raised by irrigation, in small quantities only. The great object of the people is evidently to prepare the land, by inundating it, for the crop sown in the autumn,—wheat, barley, flax, beans, &c. With the exception of the rice, and a small quantity of the grain grown during the inundation, the whole of the irrigated crops are watered with the aid of machinery. In the vicinity of Cairo, where the banks of the river have been made secure by stone facing, wells, &c., steam engines have been put up by the Pasha and his relations for their private property. In the country, the "Sakea," Persian wheel and Shadoof are employed.*

7. The fertility of the soil is wonderful; two crops of grain are often obtained from the same piece of land in the year. Manuring and rotation of crops are, however, practised every where. A crop of wheat on good land will, if irrigated, yield 8 ardeps, or about 2,400 lbs., per feddan, which is equal to about 1¾ beegahs of 160 feet square; a crop on fair land, not irrigated, will give 5 ardeps, or 1,500 lbs. per feddan, and very ordinary land will give 3 ardeps. I was informed by the cultivators that the Indian-corn produced much less grain than the wheat. The land is assessed at from 85 to 120 piastres per feddan, according to its fertility. This, in our Indian currency and measurement, would give a rate of about Rupees 6½ per beegah of 160 feet square, or about three times our rate of assessment in Sind. Labor in Egypt is about double the price it is in Sind. Inundated sandy land, in the bed of the river, is also assessed at about 100 piastres per feddan; but if the cultivator who takes it in hand should not cultivate the whole, he is not charged for the whole.

8. Having thus described the irrigation system, which has been in use for ages, I shall now notice the works of the able Engineers, M. Linant Bey and M. Mongil Bey, who have charge of the Canal Works.

9. About twenty years ago, M. Linant Bey, who had then been fifteen years in the country, perceiving the enormous expense attending the raising of water, by the Sakea, Persian wheel, &c., from the river, the impossibility of getting water at all during the low season, except from deep wells, for lands at a distance from the river, and perceiving the great gain that would be derived from irrigating the crops, instead of merely inundating the land before sowing the seed, proposed the Barrage or Regulating Bridge across the Nile, and the system of Canals in connection with it.

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* *Sakea* is I believe the chain of pots; *Shadoof* the lever and bucket called in Hindostan *dhenklee*.—ED.

M. Linant Bey's plan was to cut two new channels at the head of the Delta, to carry off the water of the Rosetta and Damietta branches, to construct a Regulating Bridge in each channel, and then completely dam up the old channels, as shown in the accompanying Map,* his object being to construct the Barrages or Regulating Bridges without being impeded by the water, as would necessarily be the case in making the Barrages across the natural channels of the river. Three large Canals—one on the left bank of the Rosetta branch, one Central Canal from the head of the Delta passing between the two Barrages, and one along the right bank of the Damietta branch—were to be constructed to supply water at all seasons, and at a high level to feed the whole of the Canals in Lower Egypt, and furnish water for keeping up the navigation. The Canal down the left bank of the Rosetta was to open a line of navigation to Alexandria. I am not aware why M. Linaut Bey's plan was not carried out as proposed, perhaps it was from the great expense of excavating the new cuts for the Rosetta and Damietta; but the plan now being carried out by M. Mongil Bey is merely a different method of effecting the same end. The Canal system is to be the same as that proposed by M. Linant, but the Barrages have been constructed in the natural channels of the Damietta and Rosetta, a little higher up than the sites proposed by that gentleman. After many years of interruption and delay, this grand work has now again been taken in hand, and may be completed in the course of a year. Both the Barrages rest on a bed of concrete sunk 21 feet into the bed of the river, which consists of loose sand. The foundations are secured both above and below the Bridges by rows of piles. The Bridge across the Rosetta consists of 64 arches of 16 feet span, with a Lock at one end for the passage of boats. That across the Damietta consists of 74 arches, and has also a Lock at one end. The head of the Delta, between the two Bridges, is protected by a revetment of stone resting on piles. The total length of the two Bridges is 1,800 feet. I was not fortunate enough to meet M. Mongil, but one of his Overseers showed me the whole of the work, which appeared to be of most excellent quality. The heads of the three Canals have been excavated; that on the Rosetta side is about 100 feet in width. The central one for the Delta is 300 feet wide at bottom, and about 10 feet deep. I believe these unusually large dimensions have been given to it, in order to furnish a very large supply of water for inundating the land during the inundation. Each Canal head will be provided with a Regulating Bridge and Lock for the passage of boats.

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* Not printed.

10. Another Canal has lately been proposed, and is about to be commenced. It is to leave the river about 10 miles above the Barrage and close to Cairo, and will run in a north-easterly direction towards the Lake Timsall, in the desert; and should the project for the great Ship Canal across the Isthmus of Suez be carried out, this fresh-water Canal from near Cairo will become of great importance for navigation as well as to supply fresh water for the shipping in the inland port of Lake Timsall. Should the Ship Canal not be made, a navigable Canal might very easily be made from Lake Timsall to Suez, and by this means a line of water communication for small vessels would be opened from Alexandria to Suez.

11. M. Linant informed me that he had another project in preparation for watering Central Egypt. He proposed constructing a Barrage a short distance below the first cataract, where there was rock on both banks, and then carrying his Canals parallel to the river, so as to supply all the minor Canals. He told me that a Barrage was indispensable in this project, in consequence of the great difference, 30 feet, that existed between the lowest level and inundation level of the Nile in that locality, and the smallness of the slope of the country.

12. M. Linant informed me, that had steam-power been as well understood when he proposed the Barrage for Lower Egypt as it is now, he would have proposed its employment, in place of constructing the Barrage, as the difficulties and expense attending the latter had been so very great; but it was only the peculiar difficulties of the case that induced him to advocate steam. Wherever there were ordinary facilities for constructing a Barrage, he would prefer that mode to using steam-power to raise the water. While considering the project mentioned in the preceding para., he told me that the question of employing steam-power had been fairly looked into, and the expense calculated; but that the result was in favor of the Barrage. He has very kindly promised to obtain for me calculations in question, which shall be duly forwarded, and I take the opportunity of mentioning here how very willingly he has afforded every assistance in his power to enable me to prosecute my enquiry.

13. I shall now make some remarks on the foregoing, with reference to the irrigation of Sind.

14. What has particularly struck me in the course of my enquiry is the fact that, though the present Canals in Egypt, from being deep and capacious, and from the comparative permanency of their mouths, furnish an abundant supply of water for the irrigation and complete submersion of the land during the inundation, and also a small quantity during the low season for irrigating lands previously inundated, it should still have been thought worth while to lavish an enormous outlay on the Barrage, and the grand feeding Canals in connection with it, to save expense in raising water and to furnish a more abundant supply during the low season. From the comparative permanency of the Canal mouths, and their great depth, and by means of the Regulating Bridges, the supply of water is infinitely more regular and abundant than it is in Sind; still it has been thought worth while to commence a new system, such as I have proposed for Sind. I have been informed that the Barrage has cost 18,000,000 francs, and that it will cost 12,000,000 more before it is completed; and probably this does not include the expense of constructing the minor masonry works for the purpose of controlling the water after it has entered the Canals; and after incurring so large an expenditure on the Barrage, still entirely new projects are being commenced on.

15. I have not observed any thing in the manner of irrigating the land in Egypt worthy of adoption, which is not practised in Sind. The plan of inundating the land by means of the Canals is also practised in Sind, but to a very small extent, because the Canals in Sind rarely furnish more water than is actually necessary for the irrigation. To practise the plan extensively in Sind, the whole of the Canals would have to be made about double their present size, which would entail an outlay very much larger than what would suffice to make an entirely new system, such as they are now carrying out in Egypt, and such as I have proposed for Sind. In our inundated tracts in Sind, I have often thought that it would be very advantageous to construct embankments, to prevent the land being injured by too much inundation, as I believe to be the case on the left bank Districts above Roree. In Egypt, the inundation of the land is under control, from the land being enclosed by strong embankments, and from the Canal

mouths being supplied with Regulating Bridges. But on the left bank Districts, the water is under no control whatever, and from this three evils arise; either there is too little water to saturate the land sufficiently, or there is so much that it flows over the irrigated crops and destroys them ; or when there is a very late inundation, the water does not retire soon enough to enable the people to sow their wheat at the proper time. Embankments made with cuts through them, and sluices to regulate the supply of water like that constructed near Sukhur, by Colonel Scott, when Superintendent of Canals, might be raised on the left bank, and perhaps other Districts with great advantage.

16. Respecting the employment of steam-power to raise water in Sind, the question is merely one of expense. As labour, and consequently the cost of raising water with the common machines in use is only half the price in Sind that it is in Egypt, it follows that steam-power, which will cost the same in both countries, cannot be employed with the same advantage in Sind that it can in Egypt. The only steam-engines constructed for irrigation in Egypt are near Cairo, and these have been constructed by the Pasha, or other members of his family, to water private property. How far it may be advisable to employ steam-power to raise water, to supply large Canals in Sind, cannot be seen until the surveys have been made. As the cost of thus raising the water is very great, it should be avoided, if possible, or at least used to a limited extent only. I do not think that it will be desirable to use steam-power, to raise water for the Canal proposed by me from Roree, though it may be so to a limited extent for the Canal from Jurruck. The steam engines used on the Nile are common pumping engines ; those used in the Lincolnshire Fens turn large scoop-wheels, which act admirably when the lift is not great ; they are commonly employed to lift the water to a height of 5 feet or less ; when the lift exceeds this, I believe the pumping engines are preferred. I shall give the subject my attention in England, and shall be glad to communicate any thing I may ascertain as to the best machines for the purpose.

17. In the other simple machines used for raising water in Egypt, I did not observe any thing worthy of adoption in Sind. The common Persian wheel universally used in Sind is also much used in Egypt. There are several kinds of Sakeas, but I did not notice any that appeared to me better adapted to the purpose than our small "Hoorla" or inun-

dation wheel in Sind. The "Shadoof," which is used in Sind for lifting the brine out of the wells for the manufacture of saltpetre, is very extensively used in Egypt. It appeared to me, that the difference in the construction of the machines arose more from the difference in the price of material in the two countries than any thing else. There are few trees in Egypt, even of the commonest kind. Wood is so scarce, that the stalk of the Indian-corn is used for fuel. Hence the mode of constructing and putting up the wheels in Sind with a quantity of wood-work is not much seen in Egypt. Either masonry is used for putting up the wheel, or the "Shadoof," which consists of a long pole and a cross piece only, is employed. Near Cairo I noticed a modification of the Persian wheel raising water for some gardens, but it did not appear to me to act so well as the simple rope and pots. The machine consisted of an endless chain passing over a wheel, which was in the form of a polygon, with a great number of sides, each of which corresponded to the length of a link of the chain. To the chain were attached vessels for holding the water. The whole machine was constructed of iron. The jerk given to the chain from the angular shape of the wheel caused a great deal of the water to be spilt.

J. G. FIFE, *Captain,*
Bombay Engineers.

LETTER *from* LIEUT.-COLONEL R. BAIRD SMITH, *Superintendent of Canals, North-Western Provinces, to* LIEUT.-COLONEL W. E. BAKER, *Secretary to the Government of India, Department Public Works, dated Roorkee,* 17*th July* 1856.

SIR,—I have the honor to acknowledge the receipt of your letter, forwarding for perusal copy of an interesting letter, under date the 4th April last, from Captain Fyfe, Bombay Engineers, on the subject of irrigation in Egypt, and directing me to submit any remarks it might suggest in connection with irrigation in Sindh.

2. Having spent about the same time in Egypt that Captain Fyfe did, and having taken the opportunity of seeing the Nile Works, and such minor works as were accessible, and of collecting a considerable amount of information, my general impressions of the Egyptian system are identical with his. I saw nothing practised in the Valley of the Nile,

whether as concerned the designs of the works, or the details of distribution and management of the water, that I would desire to see introduced into this country. Excepting the untried and imperfect modern works at the head of the Delta, the entire system seemed to be of the rudest and roughest kind, highly beneficial, no doubt, in its way, but certainly no model for imitation in Sindh or elsewhere. As regards the management of the water, the only point of importance seemed to be to have the channels big enough to give sufficient supplies for deep submersion and thorough saturation of the land. This done, the wants of the cultivators appeared to be satisfied, and in the manner of doing it, the untaught practical instinct of the people was far more visible than my influence of trained, skill, or scientific knowledge.

3. As regards the question of embanking, in connection with irrigation in Sindh or elsewhere, it is quite impossible to give an opinion without thorough local knowledge of the country. That a very complete system of embanking irrigating rivers may exist without leading to elevation of beds, or any other evil, is, I think, fairly to be inferred from the results of the Tanjore irrigation ; but there the features of the country are favorable to most effective scourage of the embanked rivers, and great use has been made of this preventive check on deposits. The practical result is that, for centuries, no elevation of the great irrigating stream, the Cavery, has been perceptible, and the local Officers assured me that, neither from their Land Revenue records, nor from any observations made since the country came into our possession, could the slightest proof be traced of evil effects attributable to the embankments. But experience in Tanjore is no warrant for like results elsewhere, unless the physical conditions of the places compared with it should be, if not identical, at least similar to such extent as to give nearly as efficient means of guarding against the gradual elevations of the river beds, so visible in certain well-known instances. Whether this be, or not, in the Valley of the Indus, I don't know, but embanking irrigating rivers is, perhaps, the most delicate process an Engineer could take in hand, and as regards Sindh, I would strongly recommend that no extensive measures should be sanctioned without the most careful investigation.

4. I do not think that the results as yet obtained from the modern works on the Nile warrant their being appealed to in justification of like works in Sindh. It seems possible enough, that these great works

may pay ultimately, but as yet they have had absolutely no influence on the agriculture of the Delta, and their fiscal results are all still to be learnt. They have been enormously expensive, and they will not be finished under an expenditure of a million and a half sterling; but whether this has been a wise expenditure, or not, yet remains to be proved. For Sind, so far as I am competent to judge, the best course seems to be, as I have before said, to maintain existing Canals as efficiently as possible for present wants, to lay down a carefully considered scheme for the ultimate rectification of the system of irrigation in the country, and to sanction no new work, that is not a part of such a scheme, and thus gradually at such rate of progress as the available means would permit, to endow the Province with really efficient means of regular irrigation.

5. As regards the systems of distribution and revenue, I believe that the best principles may be gathered from the practice in these Provinces, and may be applied in Sind with the modifications that local habits and customs may require. Bad as the Sind system in these particulars is described to be, it is not the worst in India, as it at least avoids the combination of an oppressive land assessment with a rude irrigation system, and in doing so it is so far superior to that of Madras, which I may say in passing, is, I think, by far the most unsatisfactory I have ever had an opportunity of studying.

6. With reference to the use of steam-power for irrigation in Sind, as suggested by Captain Fyfe, I can only recommend very great caution in its employment, as being in comparison with Canal works, excessively expensive. In communication with the Superintendent of the Roorkee Work shops, I have made an estimate of the comparative cost of steam-power and Canal works in delivering water; and as regards the former, the results may be considered tolerably trustworthy, as we have had long experience in the use of steam, are not far from fuel, and work as cheaply as possible. I need not trouble you with the details of calculations, but may mention that they include original cost of engines and pumps, depreciation and interest, current expense in working, and establishments for the steam-power and like elements for Canal Works. The original cost of the Ganges Canal being taken at 1½ million sterling, and its current expenses at 6 lakhs per annum, and details for the

other Canals being derived from the usual Dead Stock Accounts, the comparative results are as follow :—

Cost of delivering water by steam-power, with a lift not less than 15 feet, sufficient (inclusive of wastage) to irrigate throughout the year 1,000 acres of land...Rupees	9,642-8	or	9·64	per acre.
Cost of delivering water as above by means of the Ganges Canal Works...	1,200	or	1·2	per acre.
Cost of delivering water as above by means of the Eastern Jumna Canal	762	or	0·76	per acre.
Cost of delivering water as above by means of the Western Jumna Canal	627	or	0·63	per acre.

The average cost of delivering sufficient water for the complete irrigation of one acre, by means of Canal Works, in these Provinces, is Rupees 0-8-6, while to do the same work with steam-power would cost Rupees 9-6-4, or nearly twelve times as much. It is merely the delivery of the water that is provided for, not its distribution in irrigation, an additional expense, which would be the same in the same localities for both means. There does not seem, therefore, to be much probability of steam-power being a successful competitor with Canal Works for irrigation under ordinary circumstances.

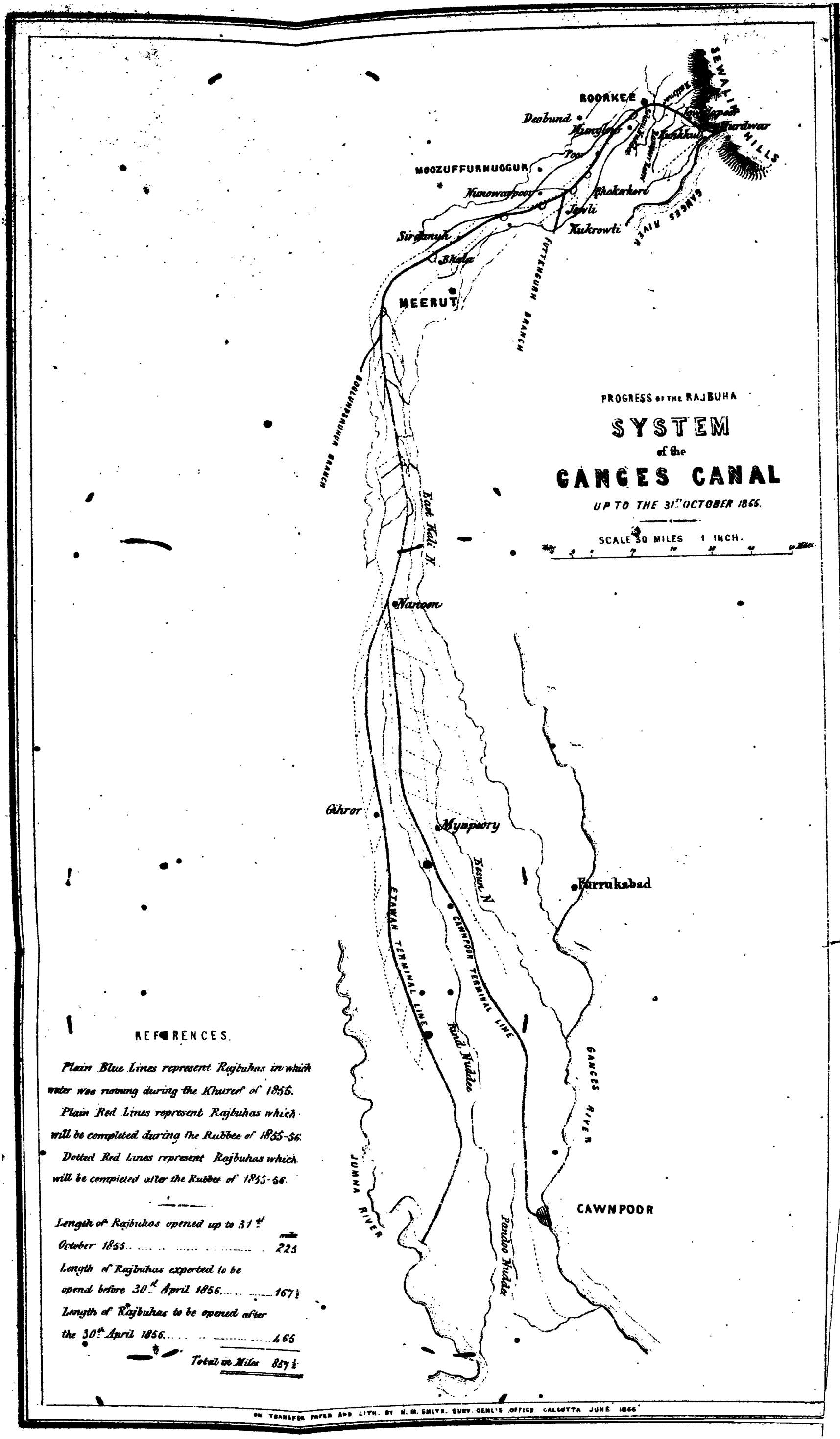
R. BAIRD SMITH, *Lieut.-Colonel,*
Superintendent of Canals, North-Western Provinces.

EXTRACT *from a* NOTE *by* LIEUT.-COLONEL W. E. BAKER, *Secretary to the Government of India in the Public Works Department, under date the 29th July* 1856.

FROM these Reports, it is evident enough, that there is nothing to be learned from the ancient practice of irrigation in Egypt, nor as yet from the more scientific and costly operations of the French Engineers.

There is only one point on which I would offer any remark.

Captain Fife (para. 14) raises the question, whether the system of embanking the irrigation channels, practised in Egypt, might not be advantageously adopted in some parts of Upper Sind, and Colonel Smith remarks (para. 3) that the practice of embanking irrigating streams has prevailed from time immemorial in Tanjore, unattended by mischievous results. From my own observations, I believe that it would not be advisable to embank the irrigation channels from the Indus, for the effect of holding up the water would be to check the current and encourage the deposit of silt with which the flood waters of that river are undoubtedly charged; but it may be advisable in some localities to throw embankments across the low inundated lands, for the express purpose of encouraging the deposit of silt, and thus raising the present level. It would seem that the waters of the Nile, by the time they reach Lower Egypt, must be free from all heavy silt deposits. This is proved by the observed condition of the channels, and the exceedingly slow growth of the Delta, which has not, I believe, perceptibly encroached upon the sea, within historic times.



PROGRESS OF THE RAJBUHA

SYSTEM

of the

GANGES CANAL

UP TO THE 31st OCTOBER 1865.

SCALE 30 MILES 1 INCH.

REFERENCES.

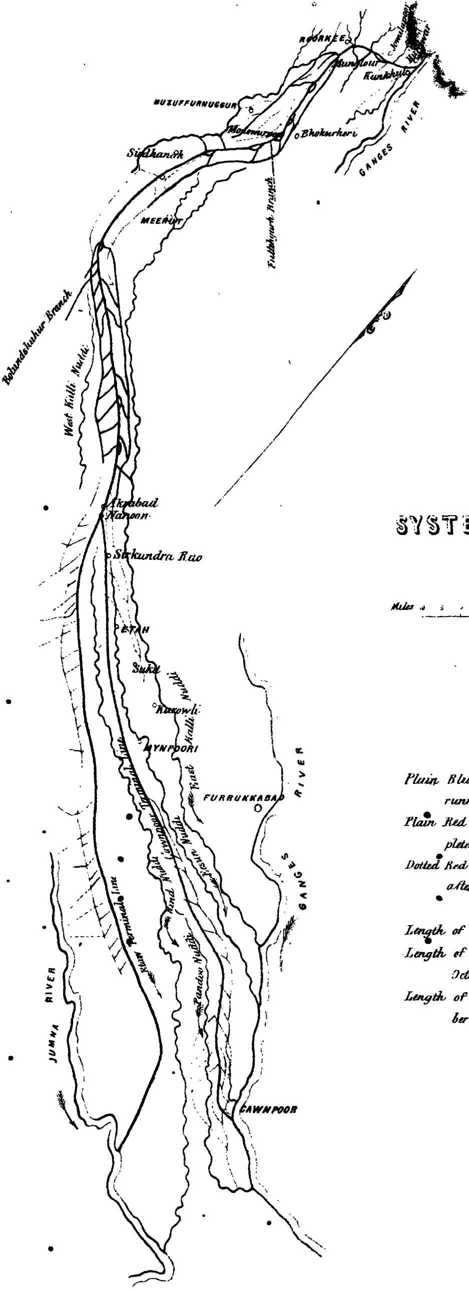
Plain Blue Lines represent Rajbuhas in which water was running during the Khureef of 1855.

Plain Red Lines represent Rajbuhas which will be completed during the Rubbee of 1855-56.

Dotted Red Lines represent Rajbuhas which will be completed after the Rubbee of 1855-56.

	miles
Length of Rajbuhas opened up to 31st October 1855	*225*
Length of Rajbuhas experted to be opend before 30th April 1856	*167½*
Length of Rajbuhas to be opened after the 30th April 1856	*465*
Total in Miles	*857½*

ON TRANSFER PAPER AND LITH. BY H. M. SMITH, SURV. GENL'S OFFICE CALCUTTA JUNE 1866



PROGRESS OF THE RAJBUHA

SYSTEM OF THE GANGES CANAL

UP TO THE 30TH APR'L 1856.

SCALE 30 MILES = 1 INCH

Miles 0 5 10 20 30 40 50 60 70 Miles

REFERENCES

Plain Blue Lines represent Rajbuhas in which water was running during the Rubbee of 1855-56.

Plain Red Lines represent Rajbuhas which will be completed during the Khureef of 1856.

Dotted Red Lines represent Rajbuhas which will be completed after the Khureef of 1856.

	miles
Length of Rajbuhas opened up to the 30th April 1856,	435
Length of Rajbuhas expeded to be opened before 31st October 1856,	436
Length of Rajbuhas to be opened after the 31st October 1856,	381
Total in Miles,	1252